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U.S. Army Environmental Center

Tooele Army Depot - South Area Suspected Releases Units

RCRA Facility Investigation - Phase II For SWMUs 1, 25, and 37

Interim Final Report

Text *and*
Appendices A, B, and C

November 1995

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13. ABSTRACT *(MAXIMUM 200 WORDS)*

This Phase II Resource Conservation and Recovery Act Facility Investigation included environmental sampling and a preliminary human health and ecological risk assessment of suspected releases Solid Waste Management Units (SWMUs) 1 and 25 and an RFI-Phase I program to determine the presence or absence of contamination at SWMU 37 at Tooele Army Depot South Area (TEAD-S), near Tooele, Utah.

SWMUs 1 and 25

The Army's objectives at TEAD-S are to prevent environmental degradation and protect installation workers and the environment during continued army use of the installation. This study concludes that there are no human health threats identified at TEAD-S Group 1 SWMUs under current use. Subsurface samples should be collected in the future to complete the characterization of these SWMUs. Risks to vegetation and wildlife were estimated qualitatively. Biota sampling is recommended to quantify these ecological risk estimates. SWMUs 1 and 25 contain unexploded ordnance and bulk explosives that would constitute a physical hazard if disturbed, but pose only a remote risk to the trained Army personnel who currently use these areas.

SWMU 37

SWMU 37 samples identified potential contamination by several metals. A Phase II program is recommended to define the extent of this potential contamination. All ordnance, slag, and ash should be removed and disposed of properly.

14. SUBJECT TERMS

Tooele Army Depot
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RESPONSES TO COMMENTS OF UTAH DIVISION OF SOLID AND HAZARDOUS WASTE

TOOELE ARMY DEPOT SOUTH AREA

RCRA Facility Investigation Phase II
Group 1 - Suspected Releases Units 1, 25, and 37

<u>General Comments</u>

Comment 1: In areas where agent was believed to be managed or disposed, samples should be collected to determine if agent or breakdown products are present. No risk assessment will be accepted for any site or media contaminated with agent or breakdown products until toxicological data for these contaminants is provided and evaluated.

Response: During the Phase II RFI, all samples collected in SWMUs 1 and 25 were screened for agent using miniCAMS equipment in the field and by the TEAD-S Surety Laboratory. The samples were then analyzed for agent breakdown products by an off-site contractor laboratory.

No agent breakdown products were selected as chemicals of concern in the risk assessment of SWMUs 1 and 25. However, as stated in paragraph 5, page 1-6, the risk assessment is preliminary because field sampling was limited. The risk assessment addressed only risks to current site workers and a hypothetical off-post farm family using data collected from surface soil. The report recommends additional characterization of the subsurface when Army policies are in place for conducting invasive work in potentially agent-contaminated soil (please see Section 6.1.4).

Comment 2: No comments will be made regarding a Quality Assurance/Quality Control Program manual for field and laboratory work and field sampling for RFI activities at TEADs. Comments concerning QA/QC will be provided subsequent to submission and review of the Chemical Data Acquisition Plan as described in the letter regarding the Monitoring Well Sampling Plan dated June 13, 1995.

Response: The Phase II RFI of Group 1 SWMUs was completed in accordance with the Quality Assurance/Quality Control Program outlined in the Data Collection Quality Assurance plan approved by the state in 1991.

Specific Comments

Comment 3: Page ES-2, paragraph 2
Executive Summary What was the purpose of samples collected in areas "... where the potential for buried munitions and agent was remote ..."?

Response: These samples were collected to characterize surface and subsurface soil in open burning and open detonation areas to determine if explosive residues or other potential contaminants were leaching to the subsurface.

Comment 4: Page 3-6, paragraph 2
3.2 How representative are these air monitoring data? A longer term composite wind rose would limit the impact of daily variations.

Response: The air monitoring data are considered representative for the following reasons:

The sampling season and monitoring locations were selected after review of long-term meteorological data collected at the installation and in the region. "High event" weather conditions (those conducive to volatilization or resuspension of contamination) were identified, and sampling was planned during the part of the year when these conditions prevail. During sampling, meteorological data were collected and used to select six sample sets out of nine collected that corresponded to periods of these high event conditions.

The wind rose on page 2-21 represents one year of data. The wind rose on page 3-5 presents data collected during Phase II RFI ambient air sampling.

Comment 5: Page 3-20 ¶ 2
3.4 Were soil samples analyzed for agent breakdown products?

Response: All samples were analyzed for agent breakdown products. Please see Section 3.11.2.1, page 3-50.

Comment 6: Page 3-20, paragraph 3
3.4 How was the reactivity of soil samples determined?

Response: The explosives concentration was measured, not reactivity. The text has been corrected to clarify this point.

Comment 7: Page 3-28, paragraph 5
36.3 If no VOCs were expected, why was analysis performed on 66 percent of the samples in SWMUs 1 and 25?

Response: These samples were analyzed to confirm that no VOCs were present in surface soil.

Comment 8: Page 3-31. paragraph 1
3.6.3 Which characteristic analyses for waste samples in SWMUs 1 and 37 were omitted and how will these data be obtained?

Response: Toxicity, ignitability, corrosivity, and reactivity analyses were omitted for some samples. These analyses should be conducted from additional samples collected during any future removal actions to provide current data to use in characterizing and arranging proper disposal of the wastes at that time.

Comment 9: Appendix L Are there human health toxicity profiles, such as those provided in Appendix L, available for chemical agent and agent breakdown products.

Response: A limited amount of toxicity data are available for these compounds. They will be added to the appendix in the revised report.

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ACRONYM LIST

ABP	agent breakdown products
AC	hydrogen cyanide
AF	assimilation fraction
Ag	silver
Agent	Distilled mustard
AID	Average Ingested Dose
Al	Aluminum
Am	Ash mounds
Army	U.S. Department of the Army
As	Arsenic
B	Boron
Ba	Barium
BAF	bioaccumulation factor
BDL	Below detection limit
Be	Beryllium
BLM	Bureau of Land Management
BNAs	base-neutral/acid extractable semivolatile organics
Br	Bromide
BTEX	benzene, toluene, ethylbenzene, xylenes
bw	body weight
CBA	Crate Burn Area
Ca	Calcium
CAOT	Covered and Open Trenches
CAMDS	Chemical Agent Munitions Disposal System
CASA	Chemical Ammunition Safeguard Area
CBA	Crate Burn Area
CCL3F	Trichlorofluoromethane
Cd	Cadmium
CDI	Chronic Daily Intake
CFS	cubic feet per second
CG	phosgene
CHCL3	Chloroform
CK	cyanogen chloride
Cl	Chloride
CMS	corrective measures study
Co	Cobalt
COC	chemical of concern
Cr	Chromium
CRL	certified reporting limit

CS	o-chlorobenzylidene malononitrile
CSDP	Chemical Stockpile Disposal Plant
CSF	Cancer Slope Factor
CT	Covered Trenches
Cu	Copper
Cyn	Cyanide
DANC	Decontaminating Agent Noncorrosive Containers
DF	Dietary Fraction
DOD	Department of Defense
DOT	U.S. Department of Transportation
DPG	Dugway Proving Ground
EBASCO	Ebasco Services Incorporated
EC50	Effect concentration where test plants weigh 50 percent less than control plants
EOD	explosive ordnance disposal
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPIC	Environmental Photographic Interpretation center
ERA	ecological risk assessment
ERTEC	Earth Technology Corporation
F	fluoride
FC2A	fluoroacetic acid
Fe	Iron
FOPs	Field Operating Procedures
FR	Feeding Rate
FS	Feasibility Study
ft	foot or feet
g	grains
GA	Tabun
GB	Sarin
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrophotometer
GPS	global positioning system
ha	hectare
HCO_3	Bicarbonate
HE	high explosive

HEA	Health Effects Assessment
HEAST	Health Effects Assessment Summary Table
Hg	Mercury
HI	hazard index
HQ	hazard quotient
HSA	hollow-stem auger
IAA	indoleacetic acid
IBA	Incendiary Burn Area
ICP	Inductively Coupled Plasma
ID	inside diameter
IDF	individual disposal feature
IRDMIS	Installation Restoration Data Management Information System
IRIS	Integrated Risk Information System
ISCST2	Industrial Source Complex Short Term
K	Potassium
Kg	Kilogram
Km	Kilometer
K_{ow}	octanol-water partition coefficients
L	Lewisite
lb	pound
LD50	lethal dose to 50 percent of the test population
LOAEL	lowest observed adverse effect level
LOEC	Lowest Observable Effects Concentration
LT	less than
MCL	maximum contaminant level
MDL	method detection limit
Mg	Magnesium
mg	milligrams
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
mi	mile
MIBK	methylisobutyl ketone
ml	milliliter
Mn	Manganese
MS	matrix spike
MSD	matrix spike duplicate

msl	mean sea level
mustard	H, HD, and HT – Mustard-T Mixture
NA	not applicable
Na	Sodium
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act
Ni	Nickel
NIT	Nitrate plus Nitrite
NO_3	Nitrate
NOAEL	no observed adverse effect level
NOEC	no observable effects concentration
OSHA	Occupational Safety and Health Administration
oz	ounce
PA/SI	Preliminary Assessment/Site Investigation
PAHs	polynuclear aromatic hydrocarbons
Pb	Lead
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QC	quality control
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recover Act
RfC	inhalation reference concentration
RfD	risk reference dose
RFI	RCRA Facility Investigation
RFI-Phase II	RCRA Facility Investigation-Phase II
RI	Remedial Investigation
RL	reporting limits
RME	reasonable maximum exposure
RNA	ribonucleic acid
RPD	relative percent difference
RV	reference value
Sb	Antimony

SCALS	Soil Conservation Action Levels
SCS	Soil Conservation Service
Se	Selenium
SF	Slope Factor
SO_4	Sulfate
SS	Split Spoon Sampling
STB	Super Tropical Bleach
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEAD	Tooele Army Depot
TEAD-AED	TEAD Ammunition Equipment Directorate
TEAD-N	Tooele Army Depot-North Area
TEAD-S	Tooele Army Depot-South Area
TEU	Army Technical Escort Unit
Tl	Thallium
TIC	Tentatively Identified Compound
TLV-TWA	threshold limit value-time-weighted average
TOC	Top of Casing
TOD	Tooele Ordnance Depot
TSP	total suspended particulates
TWA	time-weighted average
UBK	Uptake Biokinetics
UCL	Upper Confidence limit
UDWR	Utah Division of Water Rights
UF	Uncertainty Factor
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
V	Vanadium
VOCs	volatile organic compounds

VX	o-ethyl-s-(2-diisopropylaminoethyl)methyl phosphonothiolate
WP	white phosphorus
Zn	Zinc
°F	degrees Fahrenheit
µg	micrograms
µg/day	micrograms per day
µg/g	micrograms per gram
µg/l	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
µm	micromole

CHEMICAL ACRONYM LIST

Ag	silver
Al	Aluminum
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
Br	Bromide
Ca	Calcium
CCL3F	Trichlorofluoromethane
Cd	Cadmium
CHCL3	Chloroform
CK	cyanogen chloride
Cl	Chloride
Co	Cobalt
Cr	Chromium
CS	o-chlorobenzylidene malononitrile
Cu	Copper
Cyn	Cyanide
F	fluoride
FC2A	fluoroacetic acid
Fe	Iron
GA	Tabun
GB	Sarin
Hg	Mercury
K	Potassium
Mg	Magnesium
Mn	Manganese
mustard	H, HD, and HT – Mustard-T Mixture
Na	Sodium
Ni	Nickel
NIT	Nitrate plus Nitrite
NO_3	Nitrate
Pb	Lead
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
Sb	Antimony
Se	Selenium
SO_4	Sulfate
TCE	trichloroethylene

Tl	Thallium
V	Vanadium
VX	o-ethyl-s-(2-diisopropylaminoethyl)methyl phosphonothiolate
WP	white phosphorus
Zn	Zinc
13DNB	1,3-Dinitrobenzene
135TNB	1,3,5-Trinitrobenzene
24DNT	2,4-Dinitrotoluene
246TNT	2,4,6-Trinitrotoluene
26DNT	2,6-Dinitrotoluene
HMX	Cyclotetramethylenetrinitramine
RDX	Hexahydro-1,3,5-trinitro-1,3,4-triazine
TETRYL	n-Methyl-n-2,4,6-tetranitroaniline
NB	Nitrobenzene
EMPA	Ethylmethyl phosphonic acid
IMPA	Isopropylmethyl phosphonic acid
MPA	Methylphosphonic acid
FC2A	Fluoroacetic acid
111TCA	1,1,1-Trichloroethane
12EPCH	1,2-Epoxycyclohexane
2MNAP	2-Methylnaphthalene
C6H6	Benzene
B2EHP	Bis (2-ethylhexyl) phthalate
CCL4	Carbon tetrachloride
ETC6H5	Ethylbenzene
ET3MB2	Ethyl-3-methyl benzene
CH2CL2	Methylene chloride
NAP	Naphthalene
PRC6H5	Propylbenzene
MEC6H5	Toluene
Xylen	Xylenes, total
DNBP	Di-n-butylphthalate

RFI-PHASE II OF SWMUs 1 AND 25
RFI-PHASE I OF SWMU 37
EXECUTIVE SUMMARY

This report presents the results of a Phase II Resource Conservation and Recovery Act Facility Investigation (RFI-Phase II) that included environmental sampling and a preliminary human health and ecological risk assessment of two suspected releases Solid Waste Management Units (SWMUs) and an RFI-Phase I program to determine the presence or absence of contamination at a third SWMU at Tooele Army Depot-South Area (TEAD-S), near Tooele, Utah. The three SWMUs investigated include two large open burning, open detonation areas used for chemical agent munitions disposal (SWMUs 1 and 25) and slag piles and bomb fragments located in a gravel pit (SWMU 37). To characterize these SWMUs, the RFI included environmental sampling of site soil, air, and groundwater, ecological surveys, and munitions disposal pit inventories. Soil sampling was limited in most areas to surficial soil due to the potential presence of buried chemical agent. For this reason, the human health and ecological risk assessments are preliminary but will be expanded to determine the need for a corrective measures studies (CMS) at these SWMUs in the future when subsurface sampling procedures in agent-contaminated areas are in place. The objectives of the RFI/CMS at TEAD-S are to prevent environmental degradation and protect installation workers and the environment during continued industrial use of the installation. Therefore, the human health risk assessment used to evaluate current conditions includes exposure scenarios for the TEAD-S workers who are believed to have the highest exposures to potential contaminants at the Group 1 SWMUs. For reference, the human health risk assessment also evaluates hypothetical future residential use of TEAD-S by a farm family that produces part of its food on the land. However, as base closure is not currently planned for any part of TEAD-S, the risk characterization of this future residential and agrigultural use scenario is not used as the basis for corrective action decision-making. Should the Army consider releasing this area for another use, the risk characterization will be revised to evaluate the new exposure scenarios.

Location and Background

TEAD-S is a 19,355-acre site approximately 35 miles southwest of Salt Lake City in north central Utah. It is located on gently sloping to level ground in a semiarid intermountain valley. Surface water occurs infrequently as a result of seasonal snowmelt and strong thunderstorms. Most groundwater originates as precipitation in the surrounding mountains. Sediments beneath

the northeastern portion of TEAD-S, including SWMU 37, are typically coarse-grained and can transmit large volumes of groundwater at relatively fast rates. Sediments beneath the southern portion of TEAD-S, including SWMUs 1 and 25, are fine-grained and transmit smaller quantities of groundwater at slower rates. Many economic minerals occur in the mountains adjacent to TEAD-S. Therefore, the sediments underlying TEAD-S, which were eroded from the mountains, contain relatively high levels of numerous naturally occurring metals. Naturally occurring or background groundwater quality is variable across TEAD-S. Groundwater is generally fresh near the mountains and is increasingly saline toward the southwestern portion of TEAD-S. Groundwater beneath SWMUs 1 and 25 has naturally poor water quality and is nonpotable.

SWMU 1 and 25 Sampling

Most of the RFI-Phase II soil samples were collected from the surface. Subsurface samples cannot be collected in SWMU 1 or part of 25 until procedures are established by the U.S. Department of the Army for excavation in agent-contaminated areas. However, a limited number of subsurface samples were collected to determine if explosive residues or other potential contaminants were leaching to the subsurface in areas where the potential for buried munitions and agent contamination was remote. A total of 89 field investigative samples (not including quality assurance/quality control samples) were collected and analyzed under the RFI-Phase II program.

Surface and subsurface soil sampling results indicate isolated, low concentrations of various semivolatile organic compounds, including several types of polynuclear aromatic hydrocarbons (PAHs) and phthalates, some pesticides and pesticide breakdown products, an explosive compound (Tetryl), and one detection of an agent breakdown product (fluoroacetic acid). The majority of these compounds were detected in surface soil (up to 0.1 ft depth) in the vicinity of incendiary munitions disposal areas in the northeastern portion of SWMU 25, and an area of covered and open trenches at SWMU 1. Detections of these compounds in subsurface soils at the site were extremely limited. The highest metal concentrations were detected in disposal trenches in the central portion of SWMU 1 and the northeastern portion of SWMU 25. In approximately two-thirds of the sample locations there were minimal or no detections above background.

A total of 23 groundwater monitoring wells were sampled including 9 new wells that were installed as part of the RFI-Phase II program. The locations of most of the new wells were selected based on the results of a soil gas survey. Methylene chloride, carbon tetrachloride,

chloroform, and toluene were detected in SWMU 1 groundwater. These compounds were also detected in groundwater upgradient of SWMU 25. One well located downgradient of the SWMU 25 incendiary disposal area contained fuel products and possible breakdown products of explosives. A limited number of organics, primarily methylene chloride, were detected along the southern boundary of both SWMUs 1 and 25. Six metals and several anions were detected at levels above background or at regulated drinking water standards. With the exception of nitrate/nitrite, which may be present in groundwater as breakdown products of explosive compounds, these analytes are probably naturally occurring and represent groundwater quality that is naturally poor and nonpotable.

Air sampling was conducted upwind and downwind of SWMUs 1 and 25. Organics detected include methylisobutyl ketone and di-n-butylphthalate (a probable field or lab contaminant). Metals detected include aluminum, arsenic and sodium at very low concentrations. No special source of total suspended particulates over either of the SWMUs or TEAD-S as a whole was indicated by air monitoring results.

SWMU 1 and 25 Risk Assessment Results

The major findings of the human health risk assessment conducted for Group 1 SWMUs at TEAD-S are summarized as follows:

- Using very conservative selection criteria, 18 inorganic chemicals of concern (COCs) were identified for soil at SWMUs 1 and SWMU 25; 11 COCs were selected for underlying groundwater. Cancer risks and noncancer hazard indices (HIs) were calculated for both current-use (TEAD-S worker and potential indirect groundwater exposure scenarios) and future-use (hypothetical agricultural/residential scenario) exposure evaluations.

- Total cancer risks calculated for potential on-site worker exposures to soil COCs at SWMUs 1 and 25 (2×10^{-6} and 1×10^{-6}, respectively) are at the lower bound of the risk range (10^{-6} to 10^{-4}) requiring site controls accoring to the State of Utah administrative rules. Noncancer HIs (0.094 and 0.19) are less than the target HI criterion of 1.0.

- Potential inhalation risks to off-site receptors, evaluated assuming wind dispersal of soil particulates from each SWMU to the downwind Chemical Agent Munitions Disposal

System location, are well below corrective action risk criteria for both cancer and noncancer endpoints.

- A worst-case analysis of potential risks associated with uptake of groundwater COCs through the food chain yielded carcinogenic risk results (5×10^{-6}) that are within the risk range requiring site control (although attributable to background levels of arsenic and therefore not noteworthy. The noncancer HI is estimated to be 0.83).

- Total cancer risks calculated for soil exposures under the future-use residential/agricultural (farm family) scenario are 8×10^{-5} and 5×10^{-6} for SWMUs 1 and 25, respectively. These results are within the range of risks requiring site controls. Noncancer HIs (9.8 and 9.6) exceed the target HI criterion (1.0) for both SWMUs—these exceedances are attributable primarily to background levels of thallium in soil and thus are not considered noteworthy.

- The cancer risk and HI quantified for the future-use groundwater exposure scenario—4×10^{-3} (attributable primarily to background levels of arsenic) and 53.0, respectively—both exceed corrective action risk criteria. However, groundwater in the shallow aquifer beneath Group 1 SWMUs is not currently used as a potable water source due to salinity problems and low production capacity, and these conditions are not expected to change in the future. Furthermore, the pattern of groundwater analyte detections does not indicate that containment releases and migration are continuing to cause environmental degradation. Therefore, no corrective action is recommended fo groundwater.

- The results of the future-use risk evaluation should be interpreted in light of the hypothetical nature of the residential/agricultural scenario. Because future residential use of TEAD-S is not anticipated, this scenario was analyzed for comparison purposes only, and thus will not be used as the basis for any subsequent risk management decisions.

The results of the human health risk assessment, which was conducted using very conservative assumptions, indicate no potential health threats stemming from exposure to soil or groundwater COCs identified at TEAD-S Group 1 SWMUs under current site conditions. With the exception of the future-use groundwater exposure pathway, any exceedances of target risk criteria identified in the assessment were slight, and largely attributable to background levels of arsenic (soil and groundwater) and/or thallium (soil only).

The ecological risk assessment screened risks associated with eight metals and cyanide, selected on the basis of exposure and toxicological criteria, and assigned a low, moderate, or high risk ranking to each. Chromium risk was ranked high for plants and moderate for animals. Nickel and zinc risks were ranked moderate for plants. Uncertainties in the ecological risk assessment include the use of soil concentrations averaged across both SWMUs; unknown chemical forms and availability in soil; assumptions that only soil ingestion is a significant source of contaminant uptake in animals; and toxicological reference values based on surrogate species. Some of these uncertainties may result in underestimation of risks and some in overestimation. The net effect is unknown. Particularly for bioaccumulative COCs, risks are of concern for higher trophic level carnivores, especially those that are year-round residents.

The RFI-Phase II field program included an explosive risk determination in SWMUs 1 and 25. This field effort identified UXO and bulk explosives that would constitute a physical hazard if disturbed. This effort included a subjective relative ranking of explosive risk according to the type and condition of ordnance or explosives at each disposal feature. High risks were identified in parts of both SWMUs 1 and 25 because of the presence of live ordnance and bulk explosives at the ground surface. However, as entry into these areas is limited to occasional visits by TEAD workers with training in UXO recognition and avoidance, the risk of explosion is remote under conditions of present use by Army personnel.

SWMU 1 and 25 Recommendations

The human health risk assessment of SWMUs 1 and 25 under conditions of current use by Army personnel indicates no cleanup of the soil in this area is required. However, these conclusions are preliminary since the potential for agent contamination prevented examination of ordnance or other debris in open disposal pits, excavation of closed disposal pits, or subsurface soil sampling in SWMU 1 or parts of SWMU 25. Although the surficial soil sampling conducted in the RFI-Phase II is believed to have provided data adequate to characterize human health risks associated with exposures under current use conditions, subsurface contamination has not been characterized. Therefore, when Army policy and procedures are available for excavation in potentially agent-contaminated areas, an additional phase of RFI sampling and analysis is recommended to complete the characterization of both covered and open disposal features and their contents. When this sampling is completed, the human health risk assessment should be expanded to evaluate these additional data.

Since the preliminary ecological risk assessment identified potential risks to the environment associated with certain metals in SWMUs 1 and 25, this assessment should be expanded into a quantitative characterization of ecological risk. To support this quantitative assessment, biota samples should be collected to establish the levels of COCs that are present in wildlife in this area.

SWMU 37 Sampling Results and Recommendations

The RFI-Phase I of SWMU 37 included collection of 10 soil samples from slag and ash and from an area of backfilled soil. Low levels of di-n-butyl phthalate were detected in two samples from the slag piles. No other target organic analytes were detected in samples from this SWMU. Several metals concentrations detected in backfilled soil were above background concentrations for TEAD-S. All detected concentrations of these analytes were below action levels developed for a proposed rule on Corrective Action for SWMUs (40 CFR 264, Subpart S). However, since this backfill has not been delineated completely, additional sampling is recommended at this SWMU.

The RFI-Phase I at this SWMU did not include a detailed inventory of unexploded ordnance such as was performed during the RFI-Phase II at SWMUs 1 and 25. However, in addition to inert bomb fragments in the northern part of the gravel pit, intact incendiary bomblets were observed on and around the road leading down the north side of the pit. All ordnance, as well as the slag and ash piles, should be removed from the gravel pit and disposed of properly. A single sample of slag and ash that was analyzed for RCRA characteristics is considered to be non-hazardous, although the laboratory inadvertently omitted the required mercury analysis.

1.0 INTRODUCTION

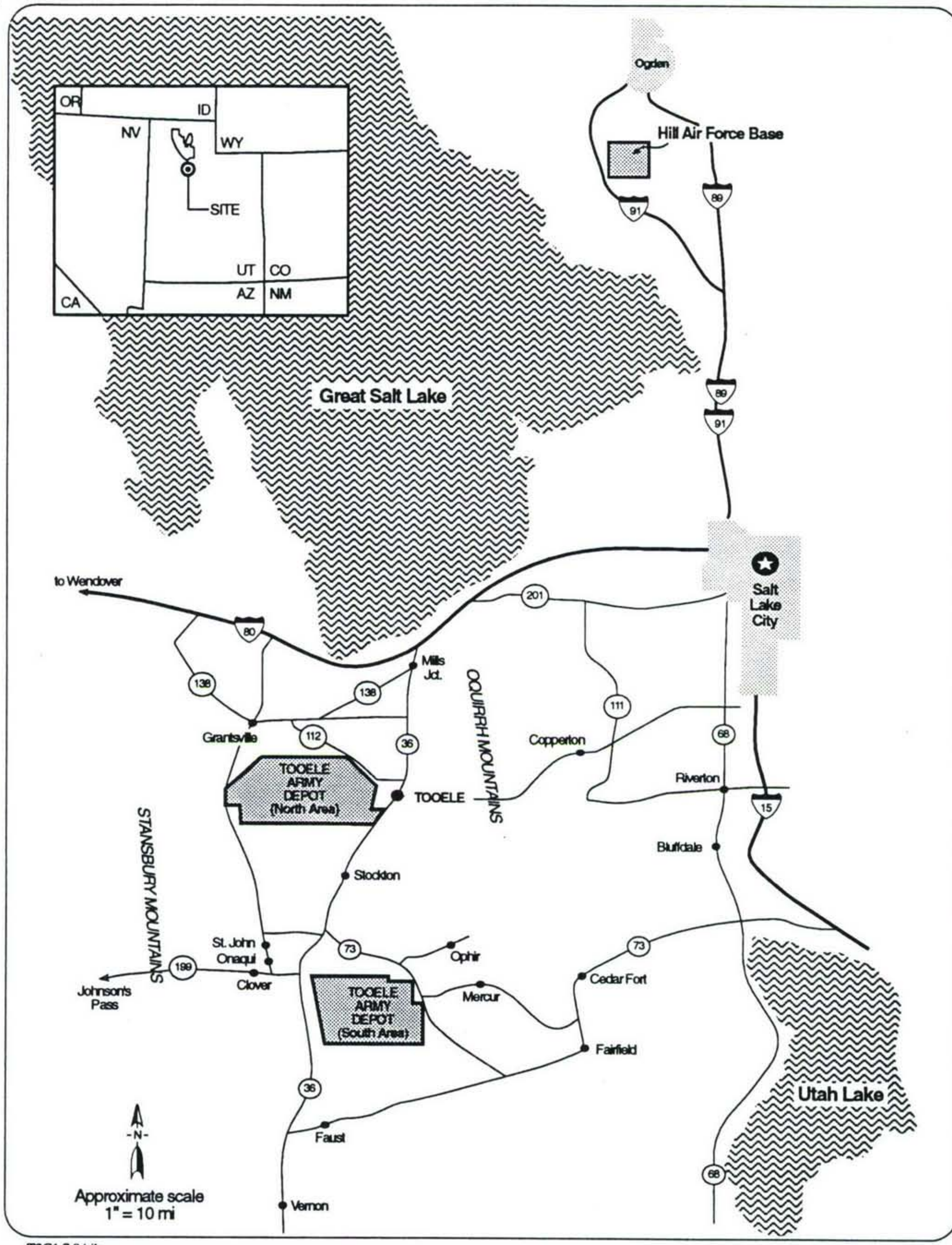
This report presents the results of environmental sampling and a preliminary human health and ecological risk assessment of three areas of the Tooele Army Depot-South Area (TEAD-S), a U.S. Department of the Army (Army) installation in north-central Utah (Figure 1.0-1). TEAD-S has been used by the Army since the 1940s, primarily for the storage of chemical weapons. This environmental study is one of the requirements of Module VII—Corrective Action for Solid Waste Management Units (SWMUs) in the TEAD-S Chemical Stockpile Disposal Plant (CSDP) Resource Conservation and Recovery Act (RCRA) Part B Permit (Permit No. UT5210090002) issued by the State of Utah to the Army.

This RCRA Facility Investigation (RFI) is being conducted by the U.S. Army Environmental Center (USAEC) and its contractor, Ebasco Services Incorporated (EBASCO). EBASCO's work was performed under Task Order 0002 of USAEC Contract No. DAAA15-91-D-0010. This work has included compilation of historical, field, and chemical analytical data from 10 previous environmental investigations of the installation, the RFI-Phase I (EBASCO 1993a), and the RFI-Phase II field program.

The RFI is being conducted on three groups of SWMUs. The Army divided the RFI into parts because RFI-Phase I funding and recommendations and funding were available for some units earlier than for others. The Group 1 SWMUs that are the subject of this report include SWMUs 1, 25, and 37 (Figure 1.0-2). The report includes the results of an RFI-Phase II of SWMUs 1 and 25 and an RFI-Phase I of SWMU 37. Table 1.0-1 summarizes the histories of these three SWMUs. The field program for the RFI-Phase II of Group 2 SWMUs is completed, and planning for the Group 3 field program is under way.

Suspected releases SWMUs 1 and 25, East and West Demilitarization Areas/Disposal Pits, are listed in Table 16 of the permit corrective action module. These SWMUs include large open burning and open disposal areas for high-explosive, incendiary, and chemical agent munitions. An additional suspected releases unit, SWMU 37, had not been identified at the time of the RFI-Phase I field program of the other suspected releases units. This SWMU consists of incendiary bomb fragments and piles of slag of unknown origin located on one side of a gravel pit.

EBASCO investigated the Group 1 SWMUs using a combination of aerial photography interpretation, employee interviews, document reviews, site visits, and environmental sampling of air, soil, and groundwater. The investigation of these SWMUs followed the final RFI-Phase II



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Source:

NUS Corporation 1987

Figure 1.0-1

Location Map of Tooele Army Depot

Tooele Army Depot - South Area
Prepared by: Ebasco Services Incorporated

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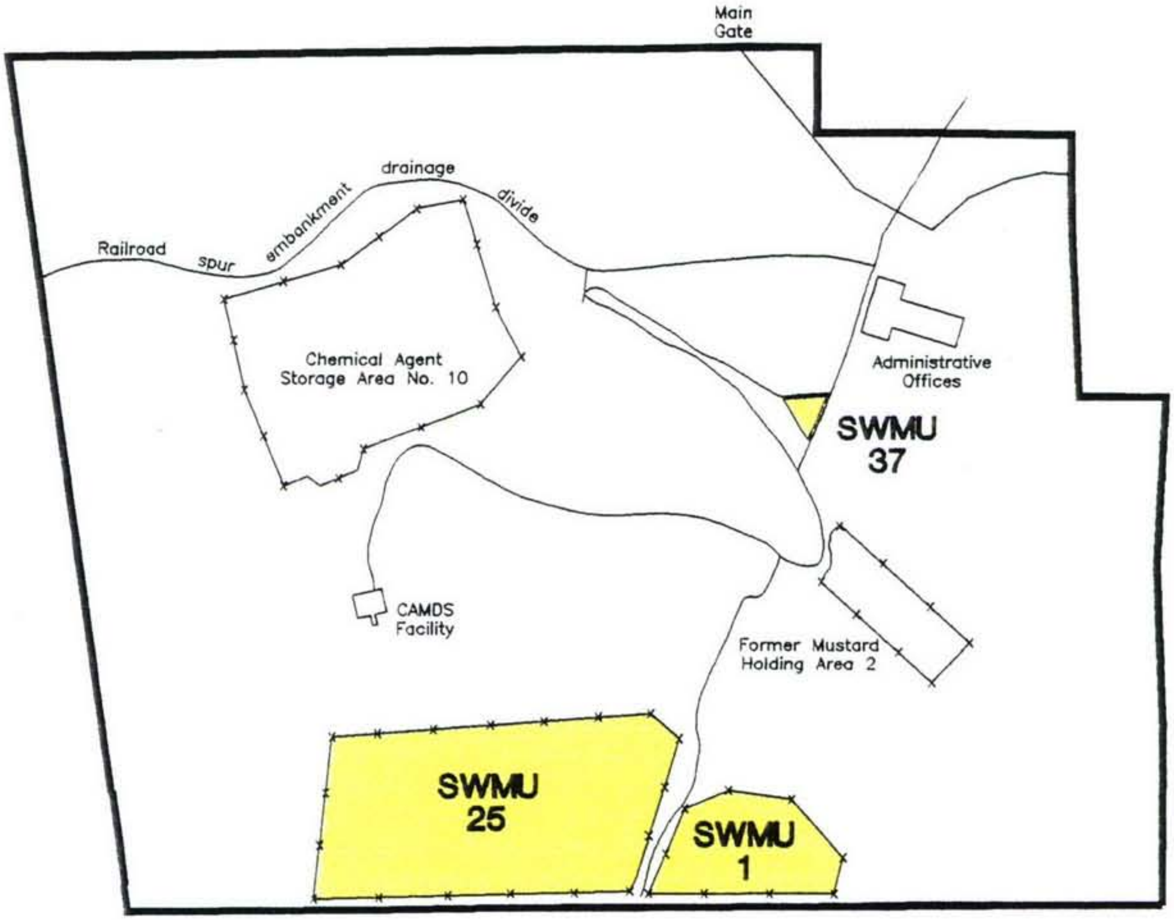
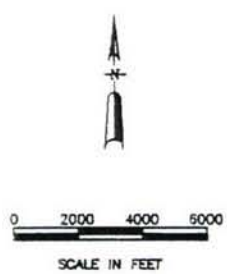


LEGEND

Location of Group 1 SWMUs
Roads
Fence
Tooele Army Depot – South Area Boundary

GROUP 1 SOLID WASTE MANAGEMENT UNITS

1. East Demilitarization Area/Disposal Pits
25. West Demilitarization Area/Disposal Pits
37. Slag Piles and Bomb Fragments



Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 1.0–2

Location of RFI–Phase II
Group 1 Investigated SWMUs

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Table 1.0-1 • SWMU History Summary, Page 1 of 1

SWMU No.	SWMU Description
1. East Demilitarization Area/Disposal Pits	This area has been used to destroy and dispose of incendiary and chemical (chiefly mustard-filled) munitions from 1945 to 1978. The majority of these activities occurred during the 1950s. Based on a 1959 Army correspondence, the demolition area was known to contain 27 disposal pits. According to this same letter, four other pits were believed to exist in SWMU 1, but their locations and contents are unknown. The Aerial Photography Interpretation Addendum (EPIC 1986) provided information on features visible in aerial photographs during 1952, 1959, and 1966. In 1952, the photo of the eastern most part of SWMU 1 showed eight ground scars and five trenches or possible pits. By 1959, the photo showed 46 trenches, approximately 25 pits, and several other unidentified features indicating heavy use of the area. Dark smudges at the southern perimeter of SWMU 1 were interpreted as possible burn areas. By 1966, five new trenches had been added and some pits had been enlarged.
25. West Demilitarization Area/Disposal Pits	A variety of demilitarization and disposal activities were conducted at SWMU 25. The western part of SWMU 25 includes approximately 50 recently closed explosion craters caused by open detonation until the 1970s. Two windrows, composed of residual metal bomb and cluster parts, are located in the north-central portion of SWMU 25. In the northeast part of SWMU 25 there are two elongated mounds composed of ash-like material of unknown origin. This ash may be the result of burning residues of incendiary munitions. A sign that reads "Danger, Buried Contaminated Chemical Munitions" is posted at the edge of one of the mounds. The eastern part of SWMU 25 contains numerous covered munitions burning and disposal pits used during the 1950s. A former site employee stated that only riot-control agents were disposed of in these pits. Aerial photographs dated 1952 (EPIC 1986) show only three trenches or possible burning areas in the eastern part of SWMU 25. By 1959, the eastern half of SWMU 25 contained numerous craters and large disturbed areas possibly indicating burning. Thirty new disposal trenches are seen in an area crisscrossed by roads. The windrow materials are visible in the 1959 photograph. By 1966, only three new trenches had been added. During a site inspection, an area of stressed vegetation was noted between the eastern trenches and the windrows.
37. Slag Piles and Bomb Fragments	This SWMU is located between SWMUs 5 and 29. It is a large gravel pit with slag piles and scattered incendiary and possibly other bomb fragments on the north side. The origin of the slag and fragments is unknown but may be from operation of a deactivation furnace.

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work plan (EBASCO 1993b), which includes a Data Collection Quality Assurance Plan, Health and Safety Plan, Project Management Plan, and Data Management Plan. Variances from the work plan are documented in the appropriate subsections within Section 3 of this report. In addition to environmental sampling activities, this RFI-Phase II included conducting ecological surveys and compiling munitions disposal pit inventories to complete characterization of these areas. This report discusses chemical analytical and other data obtained from all RFI research and field activities.

1.1 PURPOSE AND SCOPE OF REPORT

The purpose of this report is to satisfy one of the requirements of Section VII.C.1.a and Appendix A of the CSDP permit. As stated in the permit, the objective of the RFI is to characterize the environmental setting of the installation, define sources of contamination, characterize the degree and extent of contamination, identify actual and potential receptors, and evaluate potential threats to human health and the environment. The resulting data are to be of adequate technical quality to support development and evaluation of corrective measures alternatives should a corrective measures study (CMS) be required.

A corrective measures study will be required if the RFI demonstrates contamination may cause one of the following:

- Continued envionmental degradation (for example, through further contaminant releases or migration)

- Human health risks above 10^{-6} for carcinogens or a hazard index (HI) greater than 1.0 for noncarcinogens

- Adverse ecological effects

The human health risks that would trigger a corrective measures study are those estimated for exposures associated with continued use of TEAD-S by the Army for industrial purposes. Risks associated with hypothetical residential use are also estimated for each SWMU, but only for comparison to other SWMUs or other sites. Since base closure and subsequent residential use of TEAD-S are not planned, these risk estimates will not be used for decision-making. Should any part of TEAD-S be closed, all chemical or ordnance-related contamination will be reevaluated

according to stringent requirements in Army regulations governing the base realignment and closure process.

Adverse ecological effects that could result in a corrective measures study should be evaluated after tissue concentrations of bioaccumulative contaminants, which are modeled in this report, are confirmed by sampling key species in each trophic level. If the potential for adverse effects is confirmed by the sampling results, the corrective measures study should evaluate the benefits of remediation against possibly detrimental effects of habitat destruction and population disruption that might be associated with cleanup actions.

Although the Army does not plan to close TEAD-S, the possibility of base closure in the future cannot be ruled out. Therefore, even if contamination does not pose an unacceptable risk under current use conditions, the Army will prepare a corrective measures study for contamination that can be more efficiently and effectively cleaned up before future releases and migration cause additional environmental degradation.

To address these requirements, the RFI includes a Phase II environmental investigation to define the nature and extent of contamination at SWMUs 1 and 25 and a Phase I investigation of the presence or absence of contamination at SWMU 37. The field program included research on current land use in the area, ecological habitat mapping, and a key species study to identify actual and potential receptors.

The risk assessment of SWMUs 1 and 25 is considered preliminary because the scope the 1992–93 soil sampling program in these SWMUs was limited. Although contamination may occur in subsurface soil and in soil below debris that was observed in disposal pits, only surface soil samples were collected and no debris was disturbed in areas of suspected chemical agent disposal. The Army and the Utah Department of Environmental Quality, Division of Solid and Hazardous Waste, agreed to this temporary limitation on the field program to avoid excavation of agent-contaminated soil or release of agents until policies and procedures can be established to ensure that this type of contamination can be handled, stored, and disposed of safely. The Army is currently developing these policies and procedures, and the investigation of SWMUs 1 and 25 will be expanded in the future to characterize subsurface soil and soil below trench debris after these procedures are in place. When this additional field sampling is completed, the risk assessment will be finalized and used to evaluate the need for a CMS.

1.2 REPORT ORGANIZATION

This report presents the contamination assessment of SWMUs 1, 25, and 37 and baseline risk assessments of SWMUs 1 and 25. Section 1 describes the purpose and scope of this investigation.

Section 2 discusses the overall background for TEAD-S. This section outlines the history, geology and soils, surface water, groundwater, climate, vegetation, wildlife, and demography of TEAD-S and surrounding areas in Rush Valley. More detailed background discussions for each SWMU are provided in Section 4.0. A summary of previous investigations is also included in Section 2.

Section 3 dicusses the RFI-Phase II field investigation. This section provides the rationale behind each portion of the field program and summarizes the field procedures and number of samples collected. It also lists variances from the proposed RFI plan that occurred in response to field conditions during sampling. This section also discusses the chemical analyses applied to the environmental samples and the data validation, data management, and quality control results.

Section 4.1 presents the contamination assessment of SWMUs 1 and 25 providing detailed information on background and physical setting, soil, water, and air contamination, and potential fate and transport of contaminants at the two SWMUs. Section 4.2 presents the preliminary contaminant assessment at SWMU 37.

Section 5 contains the preliminary baseline risk assessments of SWMUs 1 and 25. Section 5.1 presents the quantitative human health risk assessment, and Section 5.2 presents a qualitative ecological risk assessment.

Section 6.0 presents the summary, conclusions, and recommendations for future action.

Section 7.0 lists the references cited in this report.

2.0 BACKGROUND

This section presents background information on the location, history, geology and soils, hydrology, climate, vegetation and wildlife, demography, and land and water use of the TEAD-S area. Several subsections have been updated with more recent information since the RFI-Phase I report. The information on facility history is the basis for the sampling rationale and sampling data interpretation. The information on physical site characteristics at TEAD-S supports the contamination assessment and risk evaluation as these site characteristics influence the distribution and migration of contaminants and the presence of human and ecological receptors. Information on the setting is also used to establish background levels of naturally occurring metals in site soil and groundwater.

2.1 PHYSICAL SETTING

2.1.1 Location

Tooele Army Depot (TEAD) consists of three separate areas in north-central Utah (Figure 1.0-1). The Tooele Army Depot-North Area (TEAD-N) is 7 miles (mi) south of the Great Salt Lake and 35 mi southwest of Salt Lake City. TEAD-N and TEAD-S are separated from Salt Lake City by the Oquirrh Mountains. The town of Tooele is adjacent to the east side of TEAD-N. TEAD-S, which is the subject of this RFI, is located in a separate valley 17 mi south of TEAD-N. Both TEAD-N and TEAD-S are located in Tooele County. The third property controlled by TEAD is the Non-Tactical Generator and Rail Shop Division of the Maintenance Directorate, which is at Hill Air Force Base, 25 mi north of Salt Lake City in Weber County.

TEAD-S is located in Rush Valley, with the Oquirrh Mountains to the east and the Stansbury and Onaqui Mountains to the west of the facility (Figure 2.1-1). Most of the facility is located on the east side of the valley on gently southwestward-sloping ground that is on the flank of a large alluvial fan originating from Ophir Creek. The southeastern part of the facility is located on the flank of an alluvial fan originating from Mercur Creek. The southern and western parts of TEAD-S occupy the relatively level valley bottom. Two-lane state highways pass near the site on the north, east, and west sides. The Union Pacific railroad uses the tracks adjacent to the western boundary of the installation.

The entrance to TEAD-S is off State Highway 73, at the northeast corner of the installation, on the east side of Rush Valley. Figure 1.0-2 presents a map of the TEAD-S facility. Near the entrance gate are active administrative buildings and warehouses and the site of a former housing area. To the west of the main gate is a large secured chemical storage area where chemical agent is stored in bunkers or igloos; and to the south is the former mustard holding area, in which

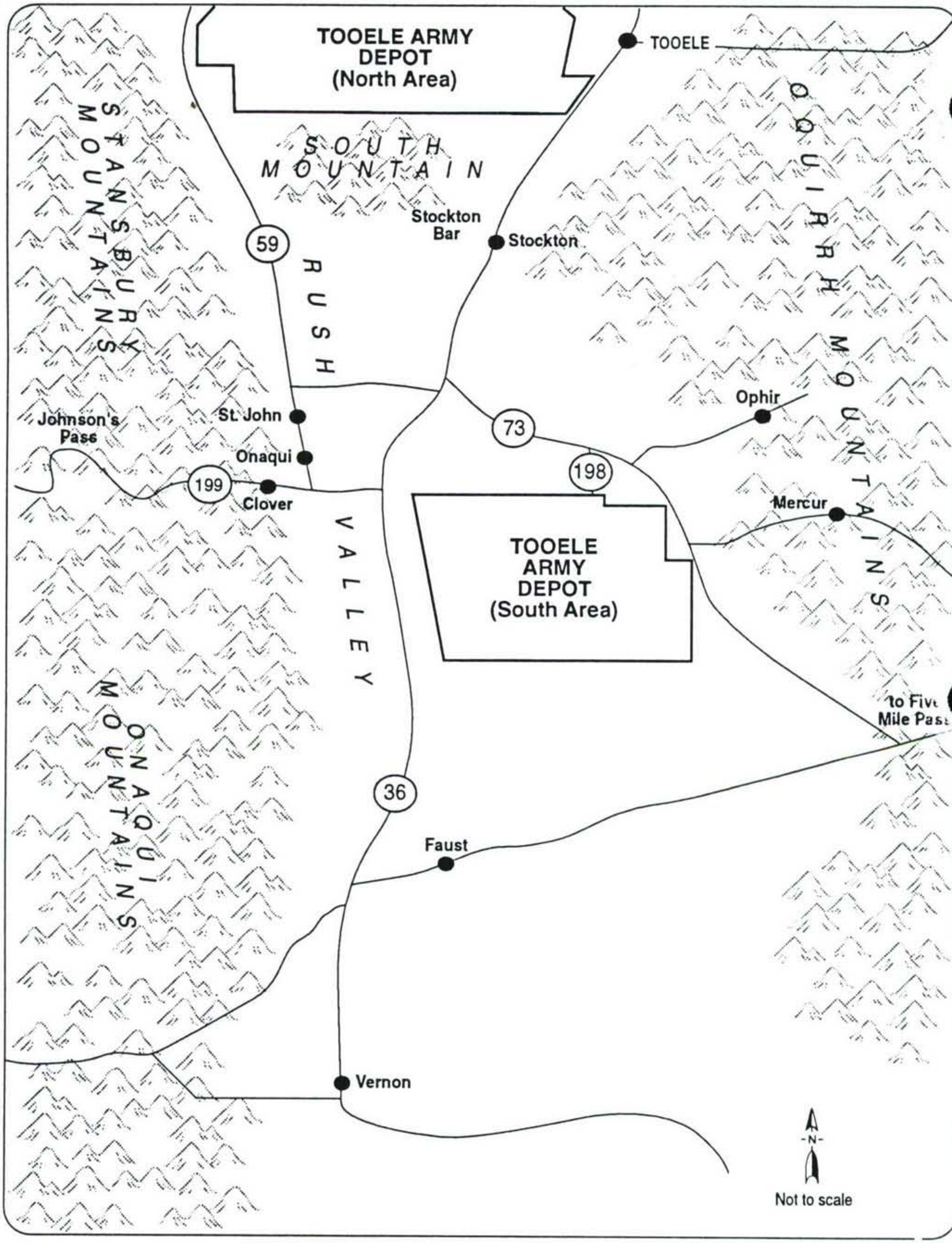

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Figure 2.1-1

Location of TEAD-S in Rush Valley

Tooele Army Depot - South Area
Prepared by: Ebasco Services Incorporated

EBASCO

warehouses are still used for a variety of storage purposes, including permitted hazardous waste storage. Former storage magazine areas crossed by roads and railroad tracks are still visible in the central part of the site as evidenced by disturbed vegetation. In the southwestern part of TEAD-S is a small chemical agent munitions disposal system (CAMDS) used for research and development. In addition, a larger chemical stockpile disposal plant was recently constructed to the east of the chemical storage area and is currently undergoing testing.

The three sites investigated under this part of the RFI-Phase II are SWMUs 1, 25, and 37 (Figure 1.0-2). SWMUs 1 and 25, where munitions demiliterization and disposal have occurred in the past, are located along the southern boundary of TEAD-S. SWMU 37 consists of two slag piles of unknown origin and scattered bomb fragments on the north slope of a large gravel pit. This SWMU is located in the northeastern portion of TEAD-S.

2.1.2 History

TEAD-S was originally constructed as a chemical munitions facility called Deseret Chemical Depot. Construction began in 1942 and was completed in 1943. The primary mission of this facility was to provide storage and maintenance services for chemical munitions. In 1955, the Deseret Chemical Depot was placed under the command of TEAD and underwent a major expansion. At this time, it was renamed the Deseret Depot Activity, and ultimately became known as the Tooele Army Depot "South Area" (USATHAMA 1979).

TEAD-N was established by the Army Ordnance Department on April 7, 1942, as Tooele Ordnance Depot (TOD). On August 1, 1962, TOD was redesignated TEAD. The depot was a World War II reserve installation and was used primarily for storing stocks for the Benicia Arsenal (near Sacramento, California) and the Stockton Ordnance Depot, through which World War II supplies, automotive combat vehicles, and ammunition were shipped to the Pacific Theater. Agent munitions filled with mustard agent were stored at this depot until 1977 when they were moved to TEAD-S (USATHAMA 1979). After World War II, TOD's mission was gradually expanded to include the support of other Army installations in the western United States.

TEAD-S has been used since the 1940s for storage, renovation, disposal, and burial of many types of chemical agent and other munitions. These munitions included mustard, distilled mustard, and mustard-T mixture (H, HD, and HT, respectively), Lewisite (L), Sarin (GB), Tabun (GA), o-ethyl-5-(2-diisopropylaminoethyl)methyl phosponothilate (VX), phosgene (CG), o-chlorobenzyl malononitrile (CS), hydrogen cyanide (AC), cyanogen chloride (CK), sulfurtrioxide-

chlorosulfonic acid (FS), HC smoke, white phosphorus (WP), thermate, and napalm high explosives (NUS 1987). Table 2.1-1 lists explosive and propellant compounds and mixtures that have been managed at TEAD. Table 2.1-2 presents the chemical agents that have been managed at TEAD. There is no indication that biological or radiological munitions have been stored at TEAD; however, pesticides, herbicides, and fertilizers have been used at the installation by Army employees and parts of TEAD-S have been leased for grazing livestock (USATHAMA 1979).

Between 1990 and 1993, the Army constructed a large-scale demilitarization facility adjacent to the chemical storage area. This CSDP is designed to reduce chemical munitions wastes from TEAD-S to nonhazardous forms that may be disposed of conventional nonhazardous waste.

2.1.3 Topography

SWMUs 1 and 25 are located in a low-lying area along the southern boundary of TEAD-S (Figure 2.1-2). A gentle topographic ridge with a maximum elevation of approximately 5,100 ft above mean sea level separates SWMUs 1 and 25. SWMU 1 slopes gently southward toward the southern border of TEAD-S. The eastern portion of SWMU 25 slopes westward, and the western portion slopes northeastward toward a level playa with an elevation of approximately 5,040 ft. The playa area covers nearly all of the western portion of SWMU 25. Local relief is 50 ft in SWMU 1 and 40 ft in SWMU 25.

2.1.4 Geology and Soil

Rush Valley is located in the Great Basin Physiographic Province, a vast desert basin stretching from the Sierra Nevada in California to the Wasatch Range in Utah. This province is characterized by a series of north-south trending mountain ranges alternating with valleys. These alternating mountains and valleys formed during the late Miocene Epoch (5 to 23 million years ago) as the valleys were faulted downward relative to the mountains, with vertical displacements of hundreds to thousands of feet (EA 1988).

Rush Valley is approximately 30 miles long and 14 mi wide. It is bounded on the north by the Stockton Bar, on the east by the Oquirrh and East Tintic Mountains, on the south by the Sheeprock and West Tintic Mountains, and on the west by the Stansbury and Onaqui Mountains. The surrounding mountains are composed of Precambrian age metasedimentary rocks, Cambrian quartzite, Paleozoic sedimentary (mainly carbonate) rocks, Tertiary intrusive and extrusive igneous rocks, and the Pliocene Salt Lake Formation (Figure 2.1-3). Precambrian and Cambrian rocks crop out only in the Sheeprock Mountains, and so have little effect on alluvial surficial deposits in the TEAD-S area. The surrounding mountain ranges, including the Oquirrh

Table 2.1-1 Typical Explosives and Propellants Demilitarized at Tooele Army Depot[1]

Propellant/ Explosive	Chemical Formula	Composition		Uses
RDX	$C_3H_6N_6O_6$	Carbon	16.3%	Detonating Cord, Primers, Component of Mixed Explosives, Detonators, Booster for Anti-tank Mines, Burster in Small-Caliber Ammo
		Hydrogen	2.7	
		Nitrogen	37.8	
		Oxygen	43.2	
TNT	$C_7H_5N_3O_6$	Carbon	37.0%	Component of Other Explosives, Demolition Blocks, Bursters, Mines, Primers
		Hydrogen	2.2	
		Nitrogen	18.5	
		Oxygen	42.3	
Tritonal	See TNT	Aluminum	20.0%	Mines, Torpedo Warheads, Depth Charges, Bombs
		TNT	80.0	
		Aluminum	30.0%	
		TNT	70.0	
		Aluminum	40.0%	
		TNT	60.0	
PETN	$C_5H_8N_4O_{12}$	Carbon	19.0%	See RDX
		Hydrogen	2.5	
		Nitrogen	17.7	
		Oxygen	60.8	
Pentolite Series				
50/50	See TNT and PETN	TNT	50.0%	Shaped Charges, Bursting Charges in Bombs and Projectiles
		PETN	50.0	
10/90	See TNT and PETN	PETN	10.0%	
		TNT	90.0	
Nitrostarch	Nitrated starch	Nitrostarch	49.0%	Projectiles, Bombs, Depth Charges, Small-Caliber Ammo, Spotting Charge
		Barium nitrate	40.0	
		Mononitronaphthalene	7.0	
		para-Nitroaniline	3.0	
		Oil	1.0	
Minol-2	NH_4NO_3	Ammonium nitrate	40.0%	See Nitrostarch
	TNT	TNT	40.0	
	Aluminum	Aluminum	20.0	

[1] Source: NUS 1987

Please see the Chemical Acronym List for acronym definitions.

Table 2.1-1 Typical Explosives and Propellants Demilitarized at Tooele Army Depot[1]

Propellant/ Explosive	Chemical Formula	Composition		Uses
HBX-1	See RDX, TNT, and Aluminum	RDX	40.0%	Boosters, Depth Charges, Torpedoes, Rockets, Mines, Bombs
		TNT	38.0	
		Aluminum	17.0	
		Desensitizer (Comp. D2)	5.0	
HBX-3	See HBX-1	RDX	31.0%	See HBX-1
		TNT	29.0	
		Aluminum	35.0	
		Comp. D2	5.0	
Explosive D	$C_6H_6N_4O_7$	Carbon	29.3%	Bombs, Projectiles, Grenades, Depth Charges
		Hydrogen	2.4	
		Nitrogen	22.7	
		Oxygen	45.6	
Dynamites				
Medium Velocity	See RDX and TNT	RDX	75.0%	Excavation, Demolition, Cratering
		TNT	15.0	
		Starch	5.0	
		Oil	4.0	
		Polyisobutylene	1.0	
Low Velocity	See RDX and TNT	RDX	17.5%	Same as above
		TNT	67.8	
		Tripentaerythritol	8.6	
		Binder	4.1	
		Cellulose acetate	2.0	
Cyclotol	See RDX and TNT	RDX	60.0%	See Explosive D
		TNT	40.0	
		RDX	65.0%	
		TNT	35.0	
		RDX	70.0%	
		TNT	30.0	
		RDX	75.0%	
		TNT	25.0	
Comp. B Series				
Comp. B	See RDX and TNT	RDX	60.0%	Projectiles, Mines, Rockets, Grenades, Bombs
		TNT	39.0	
		Wax	1.0	

[1] Source: NUS 1987

Please see the Chemical Acronym List for acronym definitions.

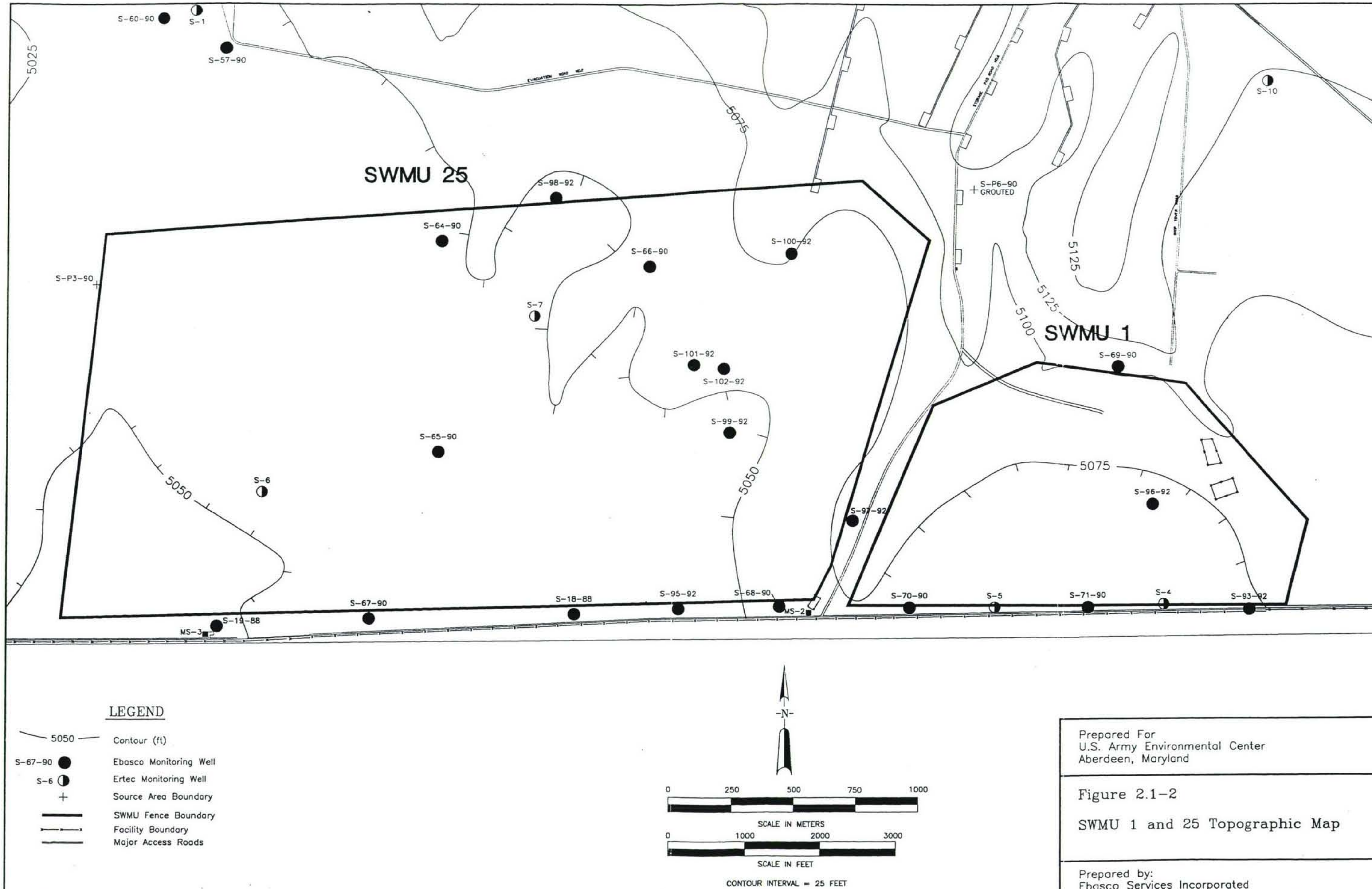
Propellant/ Explosive	Chemical Formula	Composition		Uses
Comp. B2	See RDX and TNT	RDX	60.0%	Same as above
		TNT	40.0	
Comp. B3	See RDX and TNT	RDX	59.5%	Same as above
		TNT	40.5	
Comp. B4	See RDX and TNT	RDX	60.0%	Same as above
		TNT	39.5	
		Calcium silicate	.5	
Comp. C Series				
Comp. C	See RDX	RDX	88.3%	Demolition explosive
		Plasticizer (non explosive)	11.7	
Comp. C2	See RDX	RDX	78.7%	Same as above
		Plasticizer	21.3	
Comp. C3	See RDX	RDX	77.0%	Same as above
		Plasticizer	23.0	
Comp. C4	See RDX	RDX	91.0%	Same as above
		Polyisobutylene	2.1	
		Oil	1.6	
		Di(2 Ethylhexyl)sebacate	5.3	
<u>Black Powder</u>				
Classes 1-7 and 9		Potassium nitrate	74.0% ± 1.0%	Igniters, Primers,
		Sulfur	10.4 ± 1.0	Propellants,
		Charcoal	15.6 ± 1.0	Pyrotechnics
Class 8		Potassium nitrate	74.0% ± 1.0-2.0%	Detonators, Hand
		Sulfur	10.4 ± 1.5-1.0	Grenades, Signal
		Charcoal	15.6 ± 1.5-1.0	Rockets, Depth Charges, Torpedoes
<u>Amatol Series</u>				
50/50	See TNT	Ammonium nitrate	50.0%	Bombs, Projectiles,
		TNT	50.0	Cratering Charge, Bangalore Torpedoes
60/40	See TNT	Ammonium nitrate	60.0%	
		TNT	40.0	
80/20	See TNT	Ammonium nitrate	80.0%	
		TNT	20.0	

[1] Source: NUS 1987

Please see the Chemical Acronym List for acronym definitions.

Common Name	Chemical Name and Formula	Use
H (Mustard)	Bis(2-chloroethyl)sulfide $(ClCH_2CH_2)_2S$	Blister Agent
HD (Distilled Mustard)	Bis(2-chloroethyl)sulfide $(ClCH_2CH_2)_2S$	Blister Agent
HT (Mustard - T Mixture)	Similar to HD (60% HD and 40% T-a sulfur and chlorine compound similar in structure to HD)	Blister Agent
L (Lewisite)	Dichloro(2-chlorovinyl)arsine $ClCH{:}CHAsCl_2$	Blister Agent
GB (Sarin)	Isopropyl methyl phosphonofluoridate $CH_3P(O)(F)OCH(CH_3)_2$	Nerve Agent
VX	o-ethyl-s-(2-diisopropylaminoethyl) methyl phosphonothiolate $CH_3P(O)(C_2H_5O)SCH_2CH_2N[CH(CH_2)_2]_2$	Nerve Agent
GA (Tabun)	Dimethylaminoethoxy-cyanophosphine oxide $(CH_3)_2N(C_2H_5O)CNPO$	Nerve Agent
CG (Phosgene)	Carbonyl chloride $(COCl_2)$	Choking Agent
CS	o-chlorobenzylmalononitrile $ClC_6H_4CHC(CN)_2$	Riot Control Agent
B2	3-quinudidinyl benzilate $C_{21}H_{23}NO_3$	Incapacitating Agent
DM (Adamsite)	10-chloro-5,10-dihydrophenarsazine $C_{12}H_9AsClN$	Incapacitating Agent
BZ	3-quinuclidinyl benzilate $C_{21}H_{23}NO_3$	Incapacitating Agent
DM (Adamsite)	10-chloro-5,10-dihydrophenarsazine $C_{12}H_9AsClN$	Incapacitating Agent
AC	Hydrogen cyanide HCN	Blood Agent
CK	Cyanogen chloride (CNCL)	Blood Agent
FS	Sulfur trioxide-chlorosulfonic acid (Solution of sulfur trioxide (SO_3) dissolved in chlorosulfonic acid $(ClSO_3H)$)	Smoke
HC	Mix of aluminum, zinc oxide, and hexachloroethane	Smoke
WP	White phosphorus P_4	Smoke
Thermate	Thermite $(Fe_2O_3 + Al)$ with nitrate, sulfur, and binder	Incendiary Mix
M1 Thickener (Napalm)	Mixed aluminum soap (50% coconut oil acids) (25% naphthenic acids) (25% oleic acid)	Incendiary Thickener

Source: NUS 1987, Departments of the Army and Air Force 1963

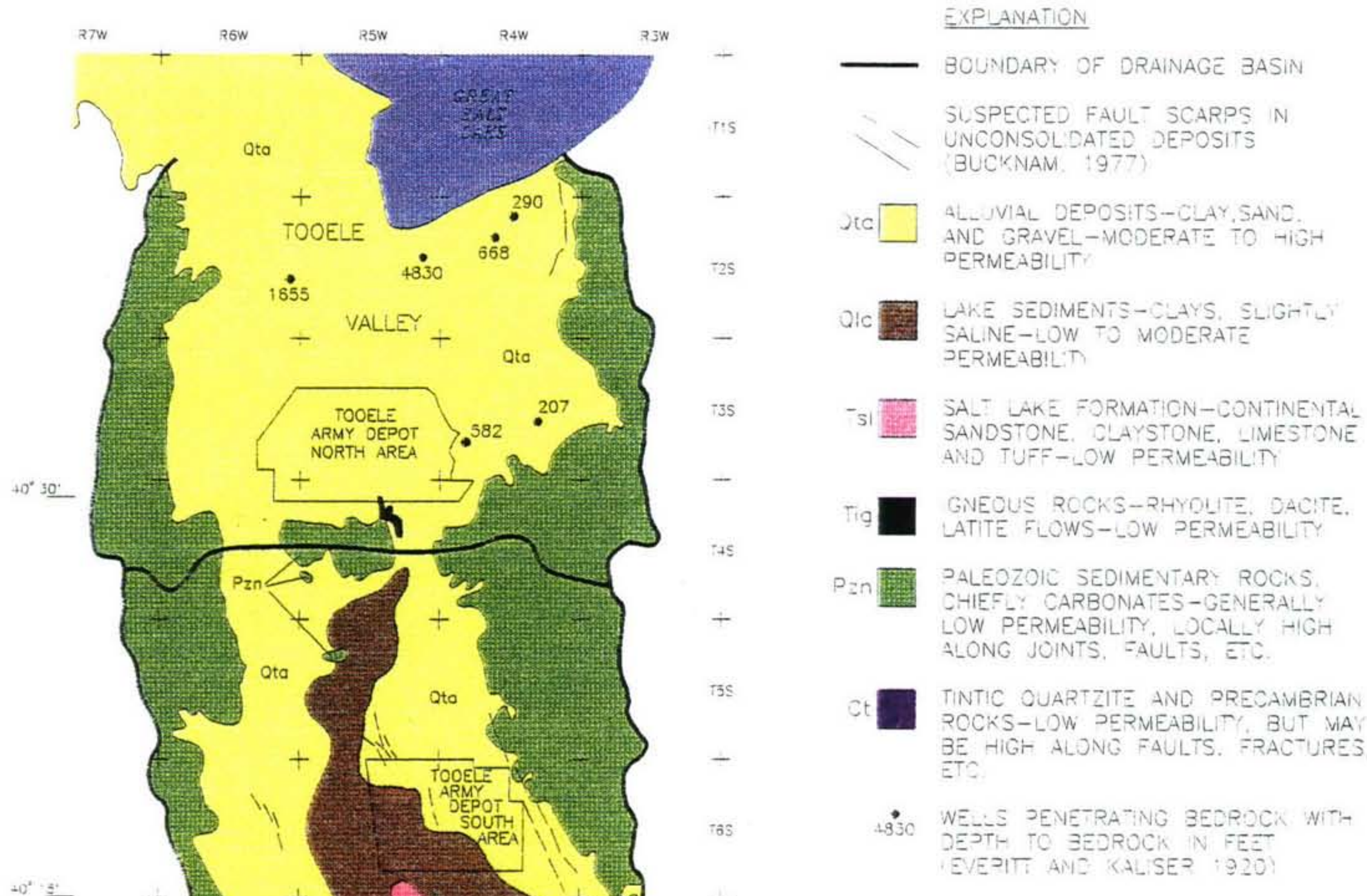


Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 2.1-2

SWMU 1 and 25 Topographic Map

Prepared by:
Ebasco Services Incorporated



Source: EPTEC, 1982

Data compiled from:
Rush Valley—Hood, and Others, 1969
Tooele Valley—Moore and Sorensen, 1979
Quaternary Faults—Bucknam, 1977

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 2.1-3

Geology of Tooele and Rush Valleys, Utah

Prepared by:
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Mountains, are composed of primarily Paleozoic sedimentary rocks which are the source of most of the alluvial and lacustrine sediments at TEAD-S. Repeated folding and faulting of the Paleozoic carbonate rocks has resulted in the development of secondary permeability in these otherwise low-permeability rocks.

Igneous intrusive rocks also crop out in the Oquirrh Mountains. The intrusive rocks contain localized metal deposits that may have influenced the geochemistry of valley sediments eroded from this area. Mining is ongoing in the Oquirrh Mountains east of TEAD-S including the Mercur Creek area. Metals mined in this area include gold, silver, arsenic, antimony, beryllium, and tellurium (EA 1988). Mines in Tooele County produce 50 percent of the nation's beryllium ore (Inland Pacific Engineering, 1982). Erosion of these rocks and subsequent deposition of the detritus in Rush Valley is one of the causes of elevated background concentrations of these metals in TEAD-S soil compared to the soils found in nonmineralized areas.

The Pliocene Salt Lake Formation is predominantly volcanic tuff, claystone, limestone, and sandstone that has generally low permeability. The Salt Lake Formation crops out approximately one-half mile to the south of TEAD-S and may underlie the site.

Unconsolidated rocks of late Tertiary to Holocene age form the valley floor and underlie all of TEAD-S. The unconsolidated deposits are more than 400 ft thick beneath TEAD-S (Hood, Price, and Waddell 1969). These deposits are primarily clay, silt, sand, and gravel eroded from outcrops of the consolidated rocks in the adjacent mountains. These deposits are generally coarsest adjacent to the mountain fronts and become finer toward the valley floor. Most of the southwestern portion of TEAD-S is covered by 25 to 100 ft of low-permeability Pleistocene lakebed sediments that were deposited when the central portion of Rush Valley was occupied by ancient Lake Bonneville. Younger units include Pleistocene post-Lake Bonneville alluvium and Recent alluvial, lakebed, and dune sand deposits (EA 1988).

Soil at TEAD-S and in Rush Valley reflect the parent materials from which it was developed. Typically, the alluvial deposits near the mountains are coarser-grained sands and gravels and are relatively permeable. The lacustrine deposits are fine-grained, of low permeability, and typically saline or alkaline. Strong diagnostic horizons, except for salt crusts, are not typically observed

in this soil due to the low amounts of precipitation and low biological activity in the near-surface horizons.

At TEAD-S there are seven major and four minor soil types according to the Salt Lake City Office of the Soil Conservation Service (SCS) (no date) (Plate 1). The seven major soil types are the following:

- Birdow loam—Moderately permeable, some areas sandy or gravelly. Used for rangeland or cropland. Found in the northeast corner of the site.

- Bramwell silt loam—Low permeability, slightly saline, high seasonal water table. Mainly used for irrigated crops. Found in the southwestern and northwestern portions of TEAD-S.

- Cliffdown gravelly sandy loam—Moderately permeable, moderately alkaline. Used primarily for rangeland. Found in the southern half of the site.

- Hiko Peak gravelly loam—Moderately permeable, often rocky. Useful for a variety of purposes, such as building-site development and rangeland, but mostly irrigated cropland and, if irrigated, to grow alfalfa and barley. Found sitewide, but is more prevalent in the eastern half.

- Skumpah silt loam—Includes two units, one of which is more saline, the other more alkaline. Both have low permeability, a slightly high seasonal water table and high shrink- swell potential. Used mostly as rangeland and for wildlife habitat. Found in the south central and southeastern portions of the site.

- Taylorsflat loam—Includes two units, one of which is more saline, the other more alkaline; low permeability, high shrink-swell potential. Used primarily as rangeland. Found primarily in the northern half and south-central portion of the site.

- Tooele fine sandy loam—Moderate permeability, slightly saline. Used primarily as rangeland with some small irrigated areas. Found primarily in the southeastern portion of the site.

The four minor soil types occur over small areas scattered throughout the central and southern portions TEAD-S. These soil types include the Logan silt loam, the Timpie silt loam, and pits, slickens and mine dumps of anthropogenic origin. More detailed descriptions of the soil types that occur in SWMUs 1 and 25 are presented in Section 4.1.1.2. SWMU 37 is located in a gravel pit where excavation has removed the developed soil layer.

2.1.5 Surface Water

Rush Valley is part of a large drainage basin known as the Great Salt Lake Basin. This is a closed basin that has no outlet for surface water. Some of the precipitation that falls on the mountains encircling Rush Valley flows to lower elevations in streams. Most of these streams are intermittent and flow only in direct response to snowmelt and summer rainfall.

The principal intermittent streams in the northern part of Rush Valley are Ophir Creek and Mercur Creek, which enter the valley from the Oquirrh Mountains to the east, and Clover Creek, which enters from the Stansbury Mountains to the west. Faust Creek flows northward through the center of the valley, collecting water from Ophir, Mercur, and Clover Creeks, and carrying surface water from numerous other tributaries in the southern half of Rush Valley. Most of the surface water from these streams recharges groundwater, is lost through evaporation, or is used for irrigation. A small amount of surface water from these streams reaches playas south and southeast of TEAD-S. Some surface water also flows into Rush Lake, at the northern boundary of the valley. Rush Lake is also fed by springs, where groundwater discharges to the surface water system.

The land surface at TEAD-S slopes gently from the northeast to the southwest, with moderate gradients of 5 percent in the northeast to nearly flat in the southwest (Plate 2). Ophir Creek and Mercur Creek flow southwestward from the Oquirrh Mountains towards TEAD-S, and Faust Creek enters the southwestern corner of the site and flows northward (Figure 2.1-4). However, most of the water in Ophir and Mercur Creeks is diverted before it reaches TEAD-S. Ophir Creek water is diverted for irrigation, although some of it occasionally flows through the northern part of TEAD-S. Mercur Creek is channeled into a diversion ditch along eastern boundary of the site. This ditch carries Mercur Creek water to the playa area to the south of TEAD-S, rather than across the site.

Faust Creek, intermittently carrying flow from the southern half of Rush Valley, enters the southwestern corner of the site and is dammed in the west-central part of the site by the intersection of two railroad embankments (Figure 2.1-4). The north-south embankment was constructed for the Union-Pacific Railroad. The east-west embankment is part of a spur that leads east and northeast through TEAD-S. When stream flow is high, Faust Creek overflows its banks and water is ponded against the embankments. During a previous investigation (Weston 1991), Faust Creek flowed until late May 1989, and several hundred acres of land between CAMDS and the embankment junction were flooded with up to 5 ft of water until early August 1989. During the RFI-Phase I field program in summer 1990, no flooding occurred. This low

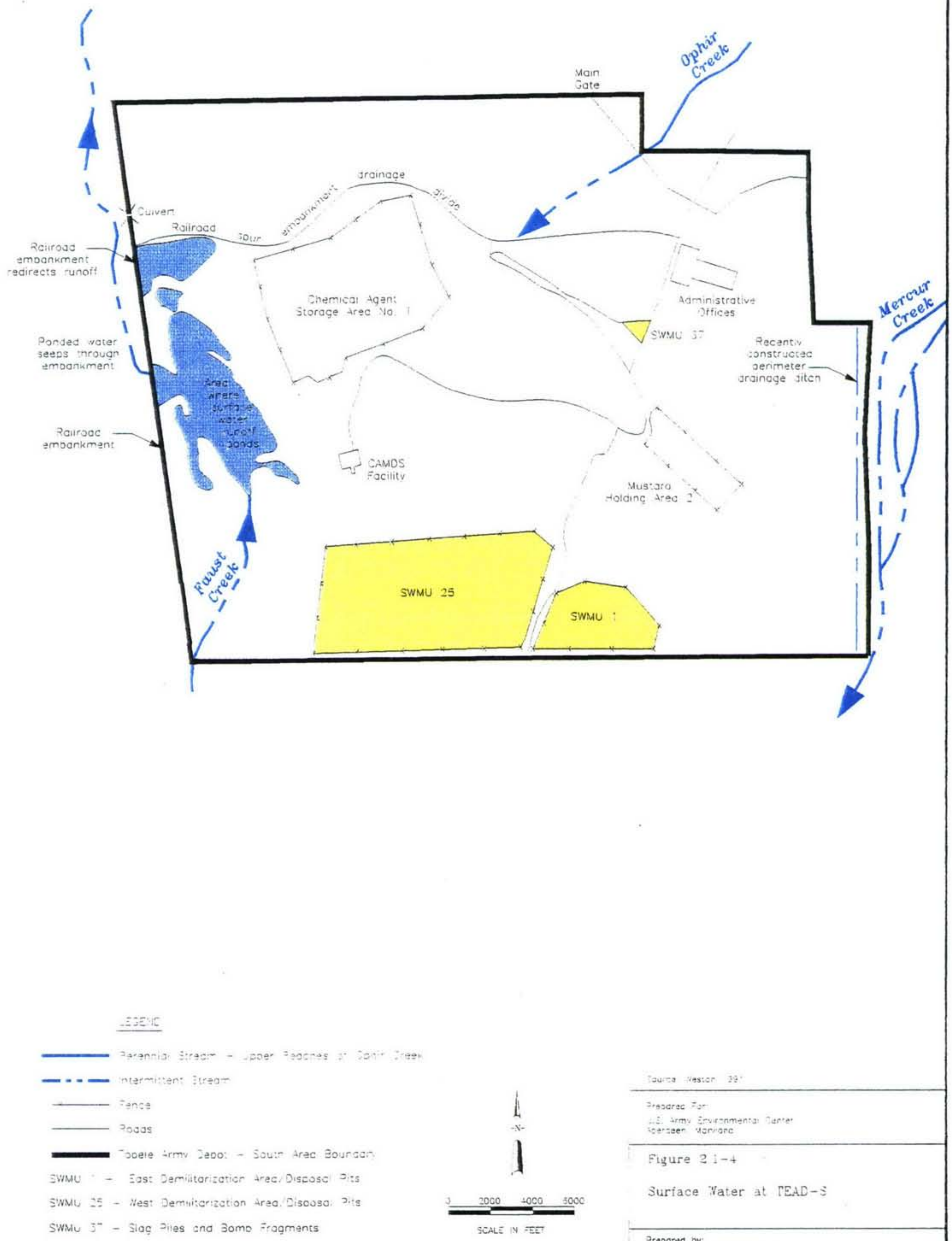

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Figure 2.1-4

Surface Water at TEAD-S

area along the western site boundary of TEAD-S was flooded again in spring 1993. During times of flooding this area may serve as a groundwater recharge area. The Faust Creek channel continues northward through the valley on the west side of the north-south embankment, eventually discharging into Rush Lake.

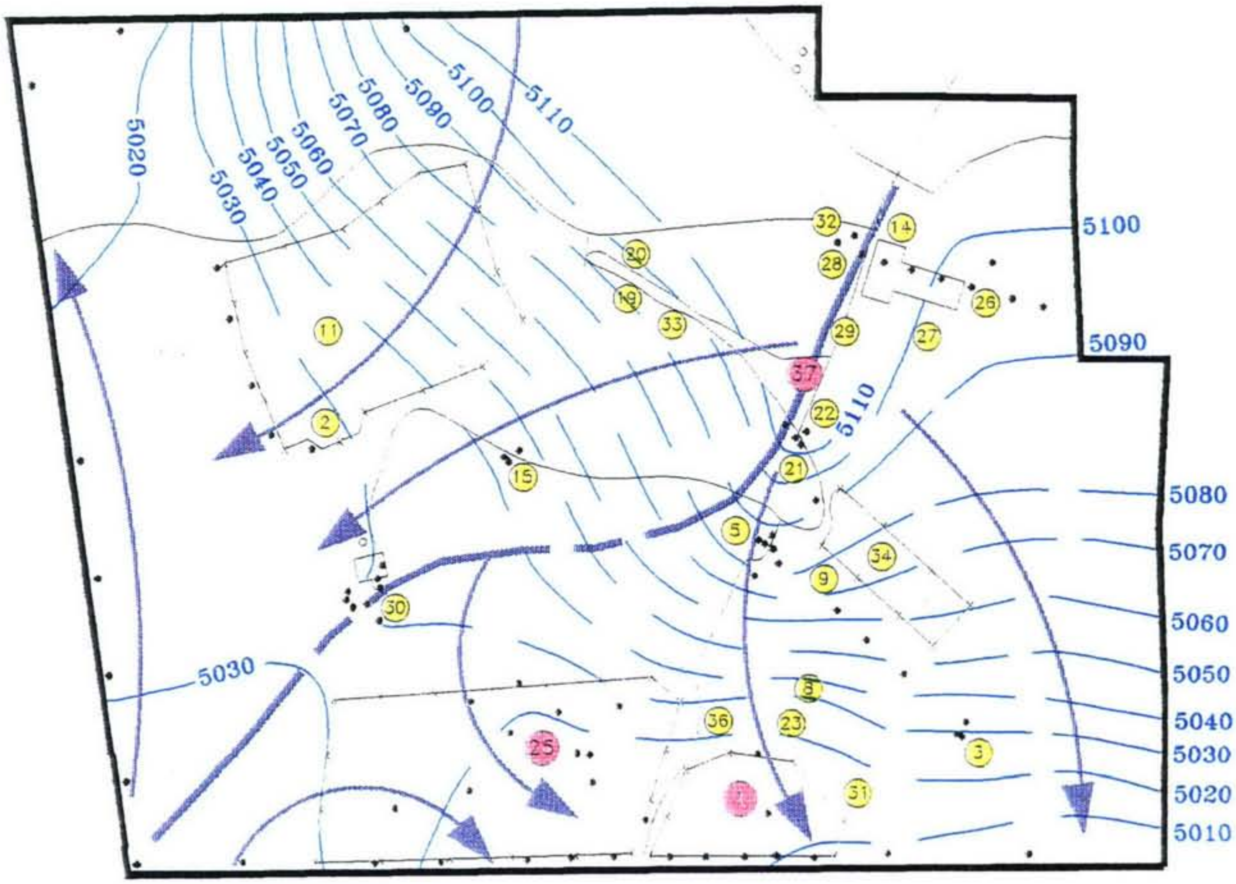
2.1.6 Groundwater

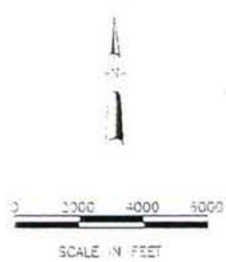
The groundwater system at TEAD-S is part of a regional flow system that includes Rush Valley and Tooele Valley. Groundwater within the regional flow system is recharged by streams that flow intermittently from the mountains in response to rain or snowmelt. These streams typically disappear through evaporation and infiltration as they cross the permeable basin sediments. This episodic flow and infiltration of runoff may affect local groundwater levels. Groundwater generally moves from these localized recharge areas to and then along the valley axis toward discharge points such as Rush Lake.

Hood, Price, and Waddell (1969) found that a regional groundwater flow divide exists in Rush Valley. The groundwater divide trends northeastward across TEAD-S (Figure 2.1-5) and is apparently the result of recharge in the area of the Ophir Creek alluvial fan. Groundwater northwest of the divide flows north toward Rush Lake, the lowest point in Rush Valley. Hood, Price, and Waddell also indicate that a small yet significant amount of groundwater discharges from Rush Valley northward under and through the Stockton Bar into the Tooele Valley. The rest of the groundwater in the Rush Lake area is lost to evaporation in Rush Lake and transpiration by vegetation in the Rush Lake area. In the southeastern part of TEAD-S, groundwater flows primarily southward. Some groundwater eventually discharges from Rush Valley to the east through the unconsolidated alluvium and structurally deformed Paleozoic rocks of the Oquirrh and East Tintic Mountains between Five Mile Pass and Ten Mile Pass (Hood, Price, and Waddell 1969). Groundwater may also discharge through evapotranspiration in and south of SWMU 25 where groundwater is less than 15 ft below the ground surface.

In the eastern part of TEAD-S, flow directions shown on Figure 2.1-4 may also be affected by local recharge. A higher water table occurs along a line through SWMUs 28, 32, 21, 22, and 5. This higher water table may be caused by leakage from a water main that parallels Montgomery Road or by discharges from buildings into ditches and septic systems in this area.

Groundwater recharge from Ophir Creek may also contribute to the higher water table in the northern part of the site. Short-term (possibly seasonal) variations in groundwater levels of up to 6 ft have been observed in monitoring wells at TEAD-S. The wells showing the greatest





Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 2.1-6

Potentiometric Surface and General Groundwater Flow Direction at TEAD-S, July, 1990

Prepared by:
Ebasco Services Incorporated

variation are located near the southwestern corner of TEAD-S, where Faust Creek enters the site during the wet season. No significant variation in groundwater flow directions have been observed.

Shallow groundwater at TEAD-S generally occurs under unconfined conditions, although it does occur in localized areas under semiconfined conditions. The depth to groundwater ranges from 289 ft in the topographically high northeastern portion of TEAD-S to 6 ft in the southwestern portion of the site and near CAMDS. As part of this RFI-Phase field program, water levels were collected during February and August 1993 from the wells in the vicinity of SWMUs 1 and 25. The interpretation of groundwater flow directions depicted in Figure 2.1-4 includes these data and data from the RFI-Phase II of SWMUs 13 and 17 conducted by SEC Donohue Inc. (now Rust Environmental and Infrastructure) (SEC Donohue 1992). The depth to water table and water table elevation maps for February and August 1993 are presented in Section 4.1.1.3 for the area around SWMUs 1 and 25.

Groundwater flow velocities vary across the site according to aquifer hydraulic conductivities and gradients. The higher velocities can occur where groundwater flows through relatively conductive coarse-grained aquifer materials, such as gravel and sand, or in areas of large hydraulic gradients. For example, higher flow velocities are expected in the northeastern portion of TEAD-S, where the aquifer material consists of alluvial sand and gravel. Lower groundwater flow velocities occur in the southwestern portions of TEAD-S, where aquifer materials consist of finer-grained lacustrine sand, silt, and clays. Estimates of average groundwater flow velocities in the SWMU 1 and 25 area are presented in Section 4.1.1.3.

2.1.7 Climate

The climate of Rush Valley is semiarid, with four well-defined seasons. Summer is hot and dry, spring and fall are generally cool, and winter is moderately cold. Average monthly temperatures range from a high of 75 degrees Fahrenheit (°F) in July to a low of 28°F in January (EA 1988). The average monthly maximum and minimum temperatures, as well as monthly extreme temperatures, are provided in Table 2.1-3 for a 6-year period from 1982 to 1987 (Tooele Army Depot Met Team 1993). Average first and last frost dates are shown in Table 2.1-4. Low humidity is characteristic of the valley climate. The average relative humidity is 44 percent (USATHAMA 1979). The annual precipitation averages 10 to 12 inches in Rush Valley, with nearly half of this amount occurring as snowfall between fall and late spring. The summers are generally dry, with occasional showers and thunderstorms. The lack of precipitation is caused by the presence of surrounding mountains that act as barriers, restricting the movement of

Table 2.1-3 Climatological Data for TEAD-S (1982–87)

	Temperature (°F)				Precipitation (inches)	
Month	Average Maximum	Average Minimum	Extreme Maximum	Extreme Minimum	Average	Maximum
January	35.0	9.0	55.0	-28.0	0.49	0.78
February	41.0	17.0	68.0	-20.0	0.55	1.40
March	50.0	25.0	76.0	-3.0	0.55	1.21
April	58.0	27.0	83.0	13.0	0.76	1.99
May	70.0	36.0	87.0	18.0	0.58	2.05
June	82.0	43.0	95.0	25.0	0.59	1.28
July	88.0	52.0	100.0	31.0	1.12	2.10
August	88.0	51.0	100.0	35.0	1.19	3.03
September	75.0	40.0	95.0	13.0	0.83	4.33
October	62.0	29.0	85.0	12.0	0.67	1.46
November	49.0	22.0	72.0	0.0	0.53	1.69
December	36.0	13.0	59.0	-15.0	0.31	1.28

Source: Tooele Army Depot Met Team (1993)

Table 2.1-4 First and Last Frost Dates for TEAD-S (1982–87)

Year	First Frost	Last Frost
1982	September 12	June 9
1983	September 21	June 14
1984	September 24	June 12
1985	September 20	May 30
1986	September 26	May 25
1987	September 17	June 3
AVERAGE	September 20	June 5

Source: Tooele Army Depot Met Team (1993)

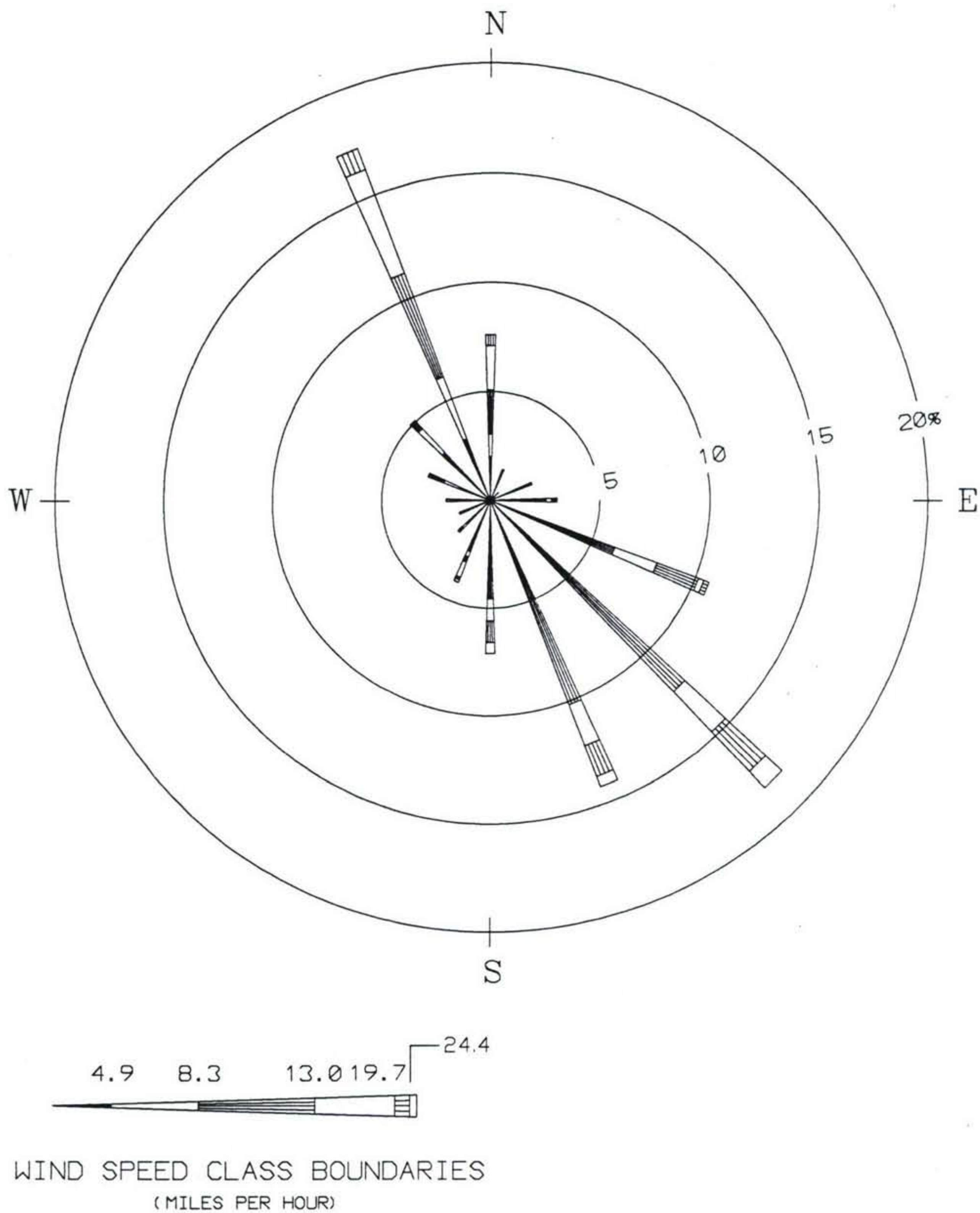
moisture into Rush Valley (Montgomery 1989). Most of the precipitation falls above an elevation of 5,500 ft (USATHAMA 1979). Table 2.1-3 provides monthly average total precipitation data for the period from 1982 to 1987.

Figure 2.1-6 provides a composite annual windrose developed from unpublished data collected by Tooele Army Depot meteorologists. These data were collected for 1986 and 1987 at meteorological station 5, located northwest of SWMU 25 along the western perimeter of TEAD-S. The data indicate a bimodal distribution along the valley axis, with a strong wind component from the north-northwest and an equally strong component from the south-southeast to southeast. This windrose reflects both seasonal and diurnal variations. The prevailing wind direction in Rush Valley is from south to north toward the Great Salt Lake during the summer and from north to south during the winter (EA 1988). Local circulations may also occur, with drainage down the sides of the higher topography during the evening and early morning hours and upslope flow on the mountain sides during the daytime. Finally, the passage of transitory synoptic weather systems (fronts, high- and low-pressure systems) across the area results in occasional flow from all directions, as is evidenced by the composite windrose. Wind speeds are generally light to moderate (9 miles per hour), except during the passage of strong frontal systems or during summertime thunderstorm activity.

Rush Valley is typical of basin and range areas where strong inversions occur during nighttime and early morning hours. These inversions generally break up during the summer, but may persist during the winter. The flow of potential regional airshed pollutants is equally distributed along the valley axis with slightly higher levels to the south where more frequent drainage of stable air occurs. These conditions were reflected in the dispersion modeling conducted for the period from August 10 to September 2, 1992, during the RFI-Phase II air monitoring program, which is discussed in more detail in Sections 3.2 and 4.1.2.4.

2.1.8 Vegetation and Wildlife

The vegetation at TEAD-S is best described as a sagebrush community throughout the eastern area and a desert shrub community on the valley floor. SWMUs 1 and 37 are within the sagebrush community, and SWMU 25 falls in a transition zone between the sagebrush and desert shrub communities (Plate 3). These plant communities are typical of the region. The U.S. Forest Service describes the sagebrush physiographic region, of which TEAD-S is a part, as extending into the central portion of the Great Basin in Utah, Nevada, and southern Idaho (Garrison, et al. 1977). The desert shrub community occurs on the salt flats of the Great Salt Lake as well as the western one-third of the Great Basin.



Source: Tooele Army Depot Met. Team 1992

Prepared For:
U.S. Army Environmental C nter
Aberdeen, Maryland

Figure 2.1-6

Windrose for TEAD-S
November 1, 1986 - October 31, 1987

Prepared by:
Ebasco Services Incorporated

The distribution of sagebrush and desert shrub communities at TEAD-S is influenced by environmental gradients in geomorphology, soil salinity, and soil drainage. In general, these parameters change along a gradient from the northeastern corner of the installation to the southwestern corner. Well-drained soils developed on alluvial material characterize the northeastern half of the installation, and poorly drained soils occur on the valley floor in the southwestern corner (see Section 2.1.3). Accordingly, soil salinity changes from relatively low to high in a northeast-to-southwest trend across the installation, and salt crusts, as a result of high rates of evapotranspiration, are often observed on the ground surface in the western part of TEAD-S.

Of the 17 vegetation types identified at TEAD-S, 6 can be grouped together into distinct habitats on the basis of their physiognomy. These types are discussed in detail in Section 5.2.2.1. Of these six habitats, the following five were found in SWMUs 1, 25, or 37:

- Upland Shrub Habitat
  - Big Sagebrush
  - Big Sagebrush, Greasewood
  - Big Sagebrush, Greasewood, Rabbitbrush

- Upland Grass Habitat
  - Bunchgrass and Annual Forbs
  - Annual Grass and Forbs

- Salt Shrub Habitat
  - Saltbush
  - Snakeweed, Saltbush, Grasses

- Alkali Meadow Habitat
  - Rabbitbrush, Alkali Grass, Juncus

- Human-Altered Habitat
  - Disturbed Areas

A wide variety of fauna characteristic of the sagebrush ecosystem and the intermountain region inhabit the vicinity of TEAD-S (see Section 5.2.2.1). Mammals in the area include mule deer, pronghorn antelope, coyote, badger, cottontails, jackrabbits, and several species of rodents. A wide variety of resident and migrant bird species typical of the intermountain region also inhabit the TEAD-S vicinity, and at least 13 species of reptiles are likely to occur.

Federal threatened and endangered species listings for site include the bald eagle and the peregrine falcon. Roosting bald eagles have been observed during winter ecological surveys along Mercur Creek and in the elm tree directly north of SWMU 1 and east of SWMU 25. No peregrine falcons have been observed on TEAD-S, but unaltered hunting habitat and a prey base exist within 16 kilometers of potential nesting habitat in the Oquirrh Mountains. The proximity of TEAD-S to this nesting habitat makes repeated usage of the facility by migrating and nesting falcons a possibility (USFWS 1984). State of Utah threatened species include the ferruginous hawk. This species has been observed on TEAD-S during ecological surveys and is a confirmed breeding bird in Rush Valley.

2.1.9 Demographics and Land and Water Use

According to the 1990 census, Tooele County has a population of 26,600, 73 percent of which is located in the cities of Tooele, Grantsville, and Wendover. There are several small towns in the vicinity of TEAD-S including Stockton, Vernon, Faust, St. John, Onaqui, Clover, and Ophir (Figure 1.0-1). The combined population of these towns is approximately 1,000.

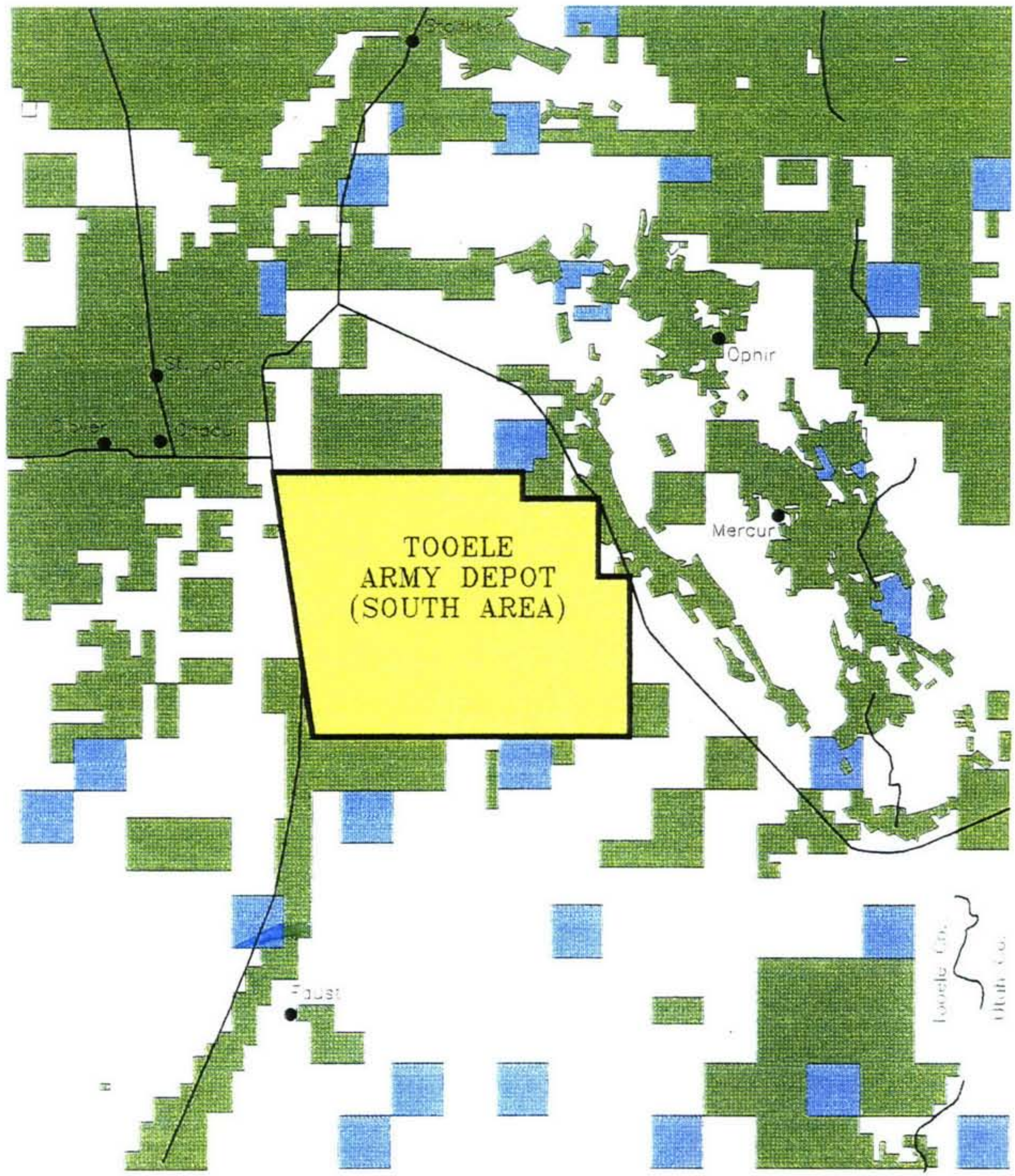
Land ownership in Tooele County is divided as follows:

- 56 percent—Federal and Indian lands
- 6 percent—State-owned land
- 38 percent—Privately owned land

Administration of the federally owned land is as follows: 55 percent is through the Bureau of Land Management (BLM), 6 percent through the Forest Service, and 39 percent through the Department of Defense (DOD).

Most of the land surrounding TEAD-S is owned by the BLM; however, the State and some private citizens own small portions of the surrounding land, especially to the northwest around the settlements of Onaqui, Clover, and St. John, (Figure 2.1-7; BLM 1979). Three industries, mining, agriculture, and government, support the local economy. The major industry involves the operation of several DOD facilities; TEAD and Dugway Proving Ground (DPG) are major employers in Tooele County. Deposits of precious metals have been mined from the Oquirrh Mountains east of TEAD-S for many years. The valley surrounding TEAD-S is used to graze livestock, including sheep, which have been observed grazing outside the south perimeter fence.

Beyond the northwestern border of TEAD-S on the west side of State Highway 36 is the BLM Clover Reservoir Wildlife Habitat Development Area, an area intended as year-round habitat for



LEGEND

Road

TEAD-S Boundary

Public Lands

State Lands

Private Lands

N

SCALE IN MILES

Source: BLM 1979

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 2.1-7

Land Use Surrounding TEAD-S

Prepared by:
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waterfowl. Waterfowl and shorebirds have been observed in the area in the last few years even though water is not always available.

The majority of the diversions, whether from wells or creeks, are used for stockwatering or irrigation, mining, or domestic purposes. A composite list of the water rights within an approximate 5-mile radius from the center of the TEAD-S site is provided in Table 2.1-5, the approximate locations of which are shown in Figure 2.1-8. This list was compiled through two searches of Utah Division of Water Rights (UDWR) records conducted in 1990 and 1993. Only one well is located downgradient of the southern perimeter source areas, and it produces from a zone approximately 50 ft below ground surface. The current status of this well is unknown.

A field crew attempted to locate and verify the water diversions known from the 1990 records search. Many of the locations were found and a global positioning system (GPS) was used to record their positions. Seven locations were not located (Figure 2.1-8). Of these seven, three sites had conditions that indicated that the well had been abandoned or impounded (Table 2.1-5). Personnel at the UDWR indicated that it is most likely that the four other diversion points have not yet been constructed (UDWR personal communication 1993).

2.2 PREVIOUS INVESTIGATIONS

The following environmental studies have been performed in TEAD-S:

1979 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an installation assessment of TEAD to identify past contamination and to assess the potential for contaminant migration. This study included a records search for information on toxic and hazardous materials use, storage, treatment, and disposal. The assessment concluded that a potential for contaminant migration existed. In TEAD-S the mustard storage areas, burial areas, and demolition grounds were thought to have a potential for contaminant migration. Of these, the Demilitarization and Disposal Pits Area (now SWMUs 1 and 25) was thought to have the highest contaminant migration potential because of shallow groundwater. The assessment concluded that the SWMU 1 burial pits should be located and investigated and that monitoring wells should be installed around landfills.

1982 Through an interagency agreement between the U.S. Environmental Protection Agency (EPA) and the Army, the Environmental Photographic Interpretation Center (EPIC) published an interpretation of aerial photographs as a follow-up to an installation assessment of TEAD-S. The photographs that were available were limited to a timeframe ranging from September 1974 and July 1981. Pits, ground scars, surface drainages, and details of the SWMUs were detailed on overlays in this report to identify areas of potential contamination and contaminant migration.

Table 2.1-5 Water Rights Within 5 Miles of TEAD-S[1]

Well No.	Owner	Use	Water Right No.	Quantity (CFS)	Depth of Source (ft)	North (ft)	East (ft)	Corner	Section	Township	Range	Field Verified
1	Ophir Creek Water Co.	Irrigation, Domestic Stockwatering, Other	a14267	11.000	Ophir Creek	S1700	E0	N4	5	6S	4W	2
2	Georgia J. Russell	Domestic Stockwatering	15 2410	0.0150	344	N600	W245	SE	32	5S	4W	5
3	TEAD-S #1	Domestic, Other	15 73	1.6300	404	S1534	E1957	NW	5	6S	4W	2
4	TEAD-S #2	Domestic, Other	15 73	1.6300	428	S1981	E2214	NW	5	6S	4W	2
5	Ophir Creek Water Co.	Irrigation, Domestic, Stockwatering	15 2273	11.000	Ophir Creek	S1580	E175	N4	5	6S	4W	2
6	Ophir Creek Water Co.	Stockwatering	15 2273	11.00	Ophir Creek	S1780	E20	N4	5	6S	4W	6
7	Gillmor	Stockwatering	15 86	0.2500	Ophir Creek	S1585	E2820	NW	5	6S	4W	2
8	Gillmor	Stockwatering	15 8	0.9500	Ophir Creek	S1585	E2820	NW	5	6S	4W	2
9	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	S1800	E2000	NW	4	6S	4W	3
10	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000	S2600	W280 0	NE	4	6S	4W	5
11	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	N2431	W185 1	SE	4	6S	4W	3
12	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	N2431	W155 1	SE	4	6S	4W	3
13	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	S3033	W489 2	NE	10	6S	4W	3
14	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	S3387	W524 6	NE	10	6S	4W	3
15	Barrick Mining	Domestic, Mining	15 2922	1.0000	1000-1500	S1850	W140 0	NE	15	6S	4W	4,7
16	Barrick Resource	Domestic, Mining	15 2922	1.0000	1000-1500	S2300	W200	NE	15	6S	4W	3
17	Barrick Resource	Other	15 2858	3.5000	Unknown	N200	E100	SW	14	6S	4W	4,7
18	USBLM	Stockwatering	15 183	0.0000	Wash	N1046	W374	SE	6	7S	4W	3

Table 2.1-5 Water Rights Within 5 Miles of TEAD-S[1]

Well No.	Owner	Use	Water Right No.	Quantity (CFS)	Depth of Source (ft)	North (ft)	East (ft)	Corner	Section	Township	Range	Field Verified
19	Priority Minerals	Domestic, Mining	15 3199	Unknown	600-1200	N1300	E1400	SW	30	6S	4W	7
20	Priority Minerals	Domestic, Mining	15 3199	Unknown	600-1200	S700	E600	NW	31	6S	4W	7
21	Stookey Estate	Stockwatering	15178	0.0150	50	S1120	E785	NW	31	6S	4W	3
22	Stookey Estate	Stockwatering	15 78	1.8	Wash	S1401	W998	E4	31	6S	4W	6
23	Clark	Irrigation, Domestic Stockwatering	15 1450	0.0150	Unknown	S445	E2370	NW	36	5S	5W	3
24	BLM	Stockwatering	15 2114	0.0000	Stream	N800	W160	S4	33	5S	5W	5
25	Tooele County	Stockwatering	15 124	0.0150	365	S1019	E1233	NW	35	6S	4W	3
26	Stookey Estate	Stockwatering	15 179	0.0150	50	S554	E1536	W4	34	6S	5W	3
27	Daniel H. Russel	Irrigation Stockwatering	15 165	5.0000	105	S600	W127 5	NE	5	6S	5W	3
28	Daniel H. Russell	Irrigation, Domestic	15 79	1.5000	100	S1756	W332 0	NE	5	6S	5W	3

Source: Utah Division of Water Rights.

ft feet
CFS Cubic feet per second
1 Specific information is not field verified.
2 On-post water diversions were not evaluated.
3 Water diversion located by a global positioning system in August 1993.
4 Location not found in August 1993.
5 Location presumed found with evidence of abandonment of this device, August 1993.
6 New locations obtained as a result of November 1993 area request; not field checked.
7 Location not found; probable diversion point not yet constructed.

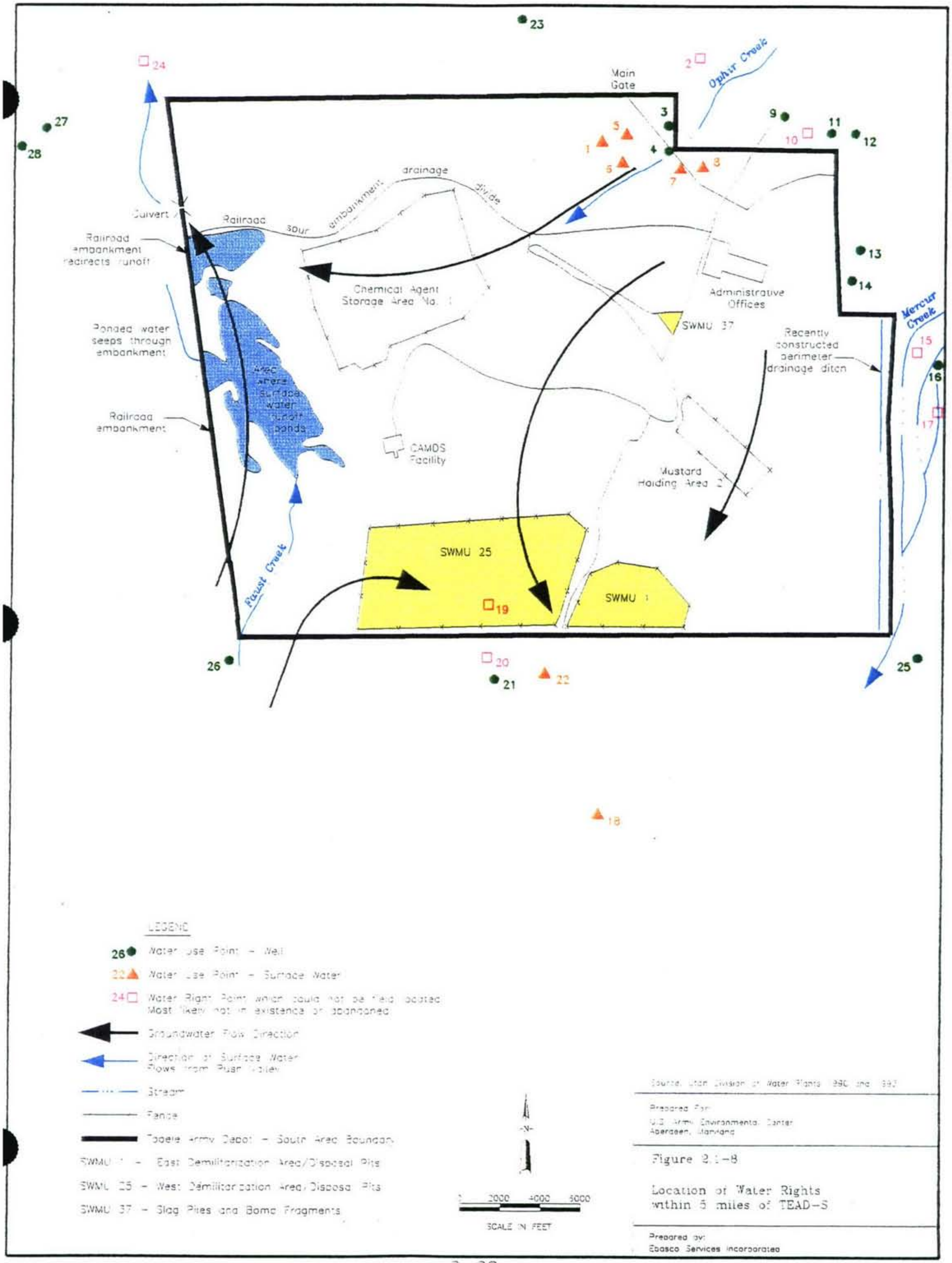

Figure 2.1-8

Location of Water Rights within 5 miles of TEAD-S

1982 Inland Pacific Engineering Company prepared a report that summarized all TEAD features that were thought to have environmental significance. Research for this study included an examination of resources in and around the installation, identification of on-post activities, and the evaluation of the potential impacts of these activities or resources on and off post. Eleven areas at TEAD-S were identified as potentially contaminated, including the demolition and burning ground area (SWMUs 1 and 25).

1982 Earth Technology Corporation (ERTEC) conducted a two-phase exploratory survey for USATHAMA that revealed minimal contamination and contaminant migration at TEAD-S. However, high levels of arsenic were found in the groundwater of the uppermost aquifer, particularly in the south-central part of TEAD-S. The study did not identify the source of the arsenic. Gross alpha and gross beta radiation were found to be high in surface water samples and in one groundwater sample, but the radiation was attributed to naturally occurring radionuclides. The survey recommended that the installation set up a semiannual groundwater monitoring program that would include all existing wells and that samples be collected in the south-central portion of the site (including SWMUs 1 and 25) for arsenic analysis.

1986 The U.S. Army Environmental Hygiene Agency (USAEHA) evaluated 31 SWMUs, 4 of which were identified during this investigation for TEAD-S. The purpose of the study was to review the adequacy of the data that had been submitted on all SWMUs as part of a pending RCRA Part B permit application for the Chemical Stockpile Disposal Plant. This study identified 7 sites that could not be classified as SWMUs and recommended their removal from the list of SWMUs; listed 18 others that needed no further investigation; and identified 6 SWMUs for additional investigation. Among the SWMUs recommended for additional investigation were SWMUs 1 and 25.

1986 EPIC prepared an aerial photography interpretation addendum that provided a more detailed study of selected sites using additional photographs. SWMUs 1 and 25 were included in this study. Demilitarization features such as trenches, pits, and craters were observed in photographic records from the years 1952, 1959, and 1966.

1987 Under contract to the EPA Region III, NUS Corporation published the Final Interim RCRA Facility Assessment of TEAD-S. This report described 29 SWMUs, including the potential presence of chemical agent. This report made recommendations as to what sampling should be conducted to assess potential threats to public health and the environment.

1988 Under contract to USATHAMA, EA Engineering, Science and Technology, Inc. completed a preliminary assessment/site investigation (PA/SI). This investigation included both a literature review and limited field investigations. The report concluded that among other sites, SWMUs 1 and 25 were either contaminated or had a high potential for contamination, including unexplained detections of toluene and a few semivolatile organic

compounds in several wells, diesel fuel and explosives in the groundwater around the CAMDS facility, explosives in one well in SWMU 25, and some possibly naturally occurring elevated levels of metals, anions, and radionuclides. No chemical agent breakdown products were detected in any samples. The report stated that the data collected were insufficient to attribute any contamination to a specific TEAD-S site.

1991 A Remedial Investigation (RI) performed for USATHAMA by Roy F. Weston investigated four parts of TEAD-S; CAMDS (SWMU 13), the deactivation furnace mercury spill area (SWMU 17), the Mustard Holding Area (SWMU 9), and the south general and perimeter areas (including SWMUs 1 and 25). An endangerment assessment of each site indicated that chromium contamination in soil at the Mustard Holding Area posed an unacceptable risk under current conditions. Other sites posed unacceptable human health risks under certain future use scenarios that were considered unlikely.

1992 An RFI-Phase II study of known releases SWMUs 13 and 17 was performed by Rust Environmental and Infrastructure (formerly SEC Donohue, Inc.) for USATHAMA. Its purpose was to determine the extent of any contamination that may be present, perform a risk assessment, and determine if a CMS is necessary for any area within the SWMUs. The investigation was also a requirement of the corrective action permit associated with the RCRA Part B permit for the CSDP. The program consisted of collecting soil, surface water, and groundwater samples. In addition, 14 new monitoring wells were installed at SWMU 13. Soil and groundwater contamination was detected in samples from SWMU 13 and it was recommended that additional sampling be performed. Sampling at SWMU 17 indicated that contamination is not a problem and that no further investigation of this SWMU is necessary.

1993 Under contract to USAEC, EBASCO (1993a) completed the RFI-Phase I of 26 SWMUs. For each SWMU, all historical data and previous sampling results were combined with the results of a limited RFI-Phase I sampling program. Soil and groundwater were sampled as part of this program and the data were evaluated to assess the presence or absence of contamination at each SWMU. Where contamination was detected, this report recommended an RFI-Phase II investigation. SWMUs 1 and 25 were included in this recommendation. SWMU 37 was not discovered until after the completion of the RFI-Phase I and it was suggested to be evaluated in the first RFI-Phase II investigation.

2.3 BACKGROUND SOIL AND GROUNDWATER GEOCHEMISTRY

As inorganic site contaminants can occur naturally in the environment, the natural background levels of these analytes must be determined in order to detect a contaminant release. Therefore, background samples were collected at Group 2 SWMUs to establish these natural inorganic concentrations. This section presents the results of the background soil and water sampling program.

2.3.1 Soil

2.3.1.1 Developing the Data Set

The background data set is composed of chemical analytical results for 23 metals and cyanide in surficial and subsurface soil samples collected during the RFI-Phase II field sampling program at Group 2 suspected releases SWMUs 3, 5, 8, 9, and 31 (Appendix F4). The background samples were collected from two boreholes drilled outside of the known or suspected area of contamination at each of these five SWMUs (Figure 2.3-1). Samples at each of the 10 locations were collected from the 0- to- 2-inch and 2- to 3-ft depth intervals.

The soil data set was divided into surface (0- to 2-inch depth interval) and subsurface soil (greater than 2 inches) subsets to complement the risk assessment exposure settings being evaluated (see Section 5). One surface soil field duplicate was collected outside the boundaries of SWMU 8 at location 8-BK-1. The detected concentrations in the field duplicate were averaged with the detected concentrations in the investigative sample to provide one set of results. If only one of the two analytical results was a detection, that value was used in the background data set. If both sample analyses were nondetections, the result was treated as nondetection in the data set with the value set at the method detection limit (MDL).

2.3.1.2 Methodology and Results

In order to determine the representativeness of background geochemical analytical results, the surface and subsurface soil data sets were analyzed for potential upper-extreme outliers. Outliers are extreme values that may not be representative of the conditions of the background population. Outliers may be the result of laboratory or analytical errors, invalid background sample locations, or actual environmental conditions.

Two outlier evaluations were conducted for each of the 23 metals and cyanide in the surface and subsurface soil data subsets. If both evaluations indicated that a result was an outlier, then it was removed from the background data set. The first outlier evaluation was qualitative. Box-and-whisker plots were created for each metal depicting the data distribution at the 5 percent, 25 percent, 50 percent, 75 percent, and 95 percent quartiles. In these plots, data that exceeded the 95 percent quartile were considered to be outliers. This method identified 22 potential outliers. Professional judgment was then used to decide whether each potential outlier should be included as a member of the population. This decision was based on the following criteria:

- The potential outlier is not the only detection in the data set
- The potential outlier is the highest detection of that analyte in either the surface or subsurface data subsets

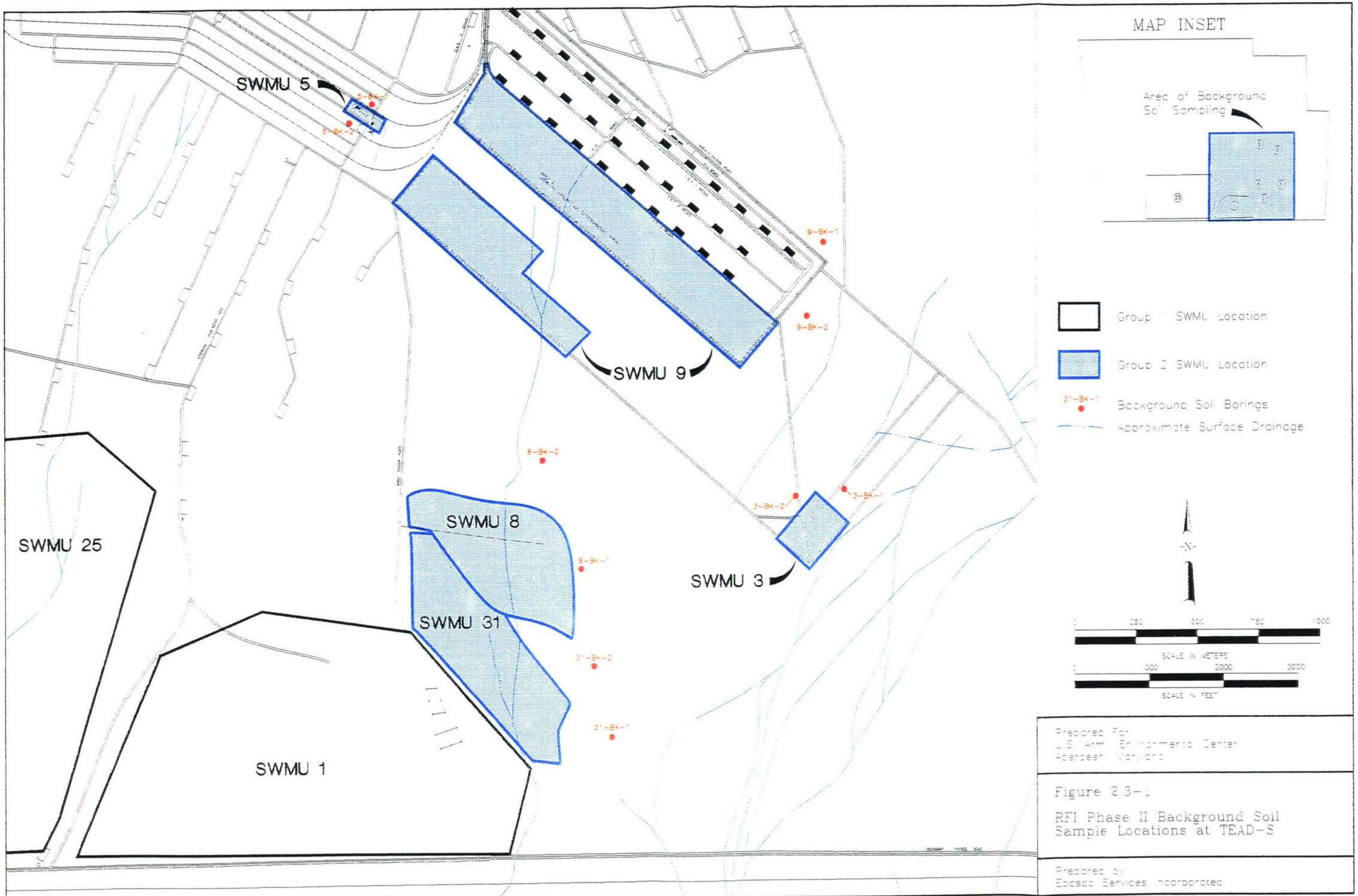

Figure 2.3-1

RFI Phase II Background Soil Sample Locations at TEAD-S

If both of these criteria were met, the potential outlier was evaluated further.

The second evaluation of potential outliers was quantitative. Using guidance provided by EPA in Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities (1992a) the maximum detection of each metal was tested as a function of the size of the population, the arithmetic mean, and standard deviation of the appropriate data set. This evaluation assumed that the values, excluding the outlier, were normally distributed. Since lognormally distributed data commonly contain values that are elevated compared to the rest of the data, the test was run on the natural logarithms of the data rather than on the original data itself. For the calculation of arithmetic mean and standard deviation, a value of one-half the analyte MDL was substituted into the data set for all nondetections. The following calculation was completed for each metal in order to determine the potential (T_n) of the maximum detection as an outlier:

$$T_n = \frac{|X_{max} - X_{mean}|}{s} \qquad \textbf{(2-1)}$$

where:

	n	=	Number of data points in the data set (n = 10)
	X_{max}	=	Natural logarithm of maximum detected value
	X_{mean}	=	Arithmetic mean of the natural logarithm of values in the data set
	s	=	Standard deviation of the natural logarithm of values in the data set

The calculated T_n was then compared to the critical T value (Table 8, Appendix B in EPA 1989a). If the calculated T_n exceeded the critical T value, this maximum value was considered to be an outlier. At this point, the maximum value was included in the data set only if data in the other data set (either surficial or subsurface) were greater.

Based on the results of both evaluations, outliers were confirmed for the following metals in the surface soil data subset: arsenic (440 micrograms per gram, or µg/g), cadmium (1.78 µg/g), copper (721 µg/g), lead (160 µg/g), and mercury (2.7 µg/g). The subsurface soil data subset did not contain any apparent outliers. All outliers were removed from the dataset prior to the determination of background values in surface soil.

In view of the relatively low number of background data, the maximum concentrations of each metal in the surface and subsurface background soil data subsets, (excluding upper-extreme

outliers), were selected as comparative background values for identification of contamination in the RFI, and chemical of concern (COC) selection for the risk assessment. Tables 2.3-1 and 2.3-2 provide summary statistics completed for the surficial and subsurface data subsets that include the range of detected concentrations, arithmetic mean, standard deviation, and background value (maximum detected concentration) for each metal.

2.3.2 Groundwater

2.3.2.1 Inorganic Analytes

In order to determine whether environmental degradation of groundwater has resulted from past activities at SWMUs 1 and 25, it is necessary to know the natural inorganic chemistry of groundwater from areas that remain unaffected by TEAD-S activities. Data used to establish background concentrations in groundwater were assembled from monitoring wells that are located hydraulically upgradient of known contaminant sources at TEAD-S and are free of organic compounds. Chemical analytical results from these wells (S-20-88, S-21-88, S-12, S-22-88, and S-69-90) were used to determine site groundwater background chemistry.

Figure 2.3-2 shows the locations of background wells at TEAD-S. Two background wells (S-20-88 and S-21-88) are located on the northwestern boundary of TEAD-S and intercept groundwater flowing onpost from the northeast. Two other wells (S-12 and S-22-88) are located on the southwestern boundary of TEAD-S and receive upgradient water flowing onpost from the Stansbury and Onaqui Mountains. The fifth well (S-69-90) is located on the northern boundary of SWMU 1. Results from well S-98-92, which was intended to be a background well for SWMU 25, were not included in the background data set because chlorinated solvents were detected in groundwater samples from this well.

Because RFI-Phase II groundwater samples for metals analyses were filtered (see Section 3.8) previous results from only filtered background samples were used in combination with these data. Statistical analyses of the data were not performed because of the limited number of data available to analyze each element in the background data set. Instead, the maximum concentration of each analyte detected in the background wells was used to establish the background level at the site.

Table 2.3-3 lists the maximum concentrations of anions and dissolved metals in TEAD-S background wells. The metals that were analyzed are antimony, arsenic, barium, beryllium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver, thallium, vanadium, and zinc. The anions are bromide, chloride, fluoride, sulfate, and nitrate/nitrite. Five elements

Analyte	Number of Samples	Number of Detections	Percent Detections	Arithmetic Mean	Standard Deviation	Minimum Detection (µg/g)	Background Value Maximum Detection (µg/g)
Aluminum (Al)	10	10	100	12,000	3,000	7,810	17,700
Antimony (Sb)	10	0	0	ND	0	ND	ND
Arsenic (As)	9	9	100	7.5	7.6	3.3	27.3
Barium (Ba)	10	10	100	200	130	61.6	536
Beryllium (Be)	10	10	100	0.62	0.19	0.303	0.893
Cadmium (Cd)	9	9	100	0.73	0.18	0.490	0.982
Calcium (Ca)	10	10	100	97,000	34,000	56,900	146,000
Chromium (Cr)	10	10	100	17	3.6	12.7	25.1
Cobalt (Co)	10	10	100	5.1	1.1	3.07	6.61
Copper (Cu)	9	9	100	19	6	9.17	25.1
Iron (Fe)	10	10	100	13,000	2,600	8,640	17,500
Lead (Pb)	9	9	100	23	8.4	9.44	34.8
Magnesium (Mg)	10	10	100	12,000	2,600	8,990	16,200
Manganese (Mn)	10	10	100	490	140	221	658
Mercury (Hg)	9	6	67	0.04	0.03	ND	0.084
Nickel (Ni)	10	10	100	15	2.6	11.8	19.5
Potassium (K)	10	10	100	5,200	1,900	2,270	7,940
Selenium (Se)	10	0	0	ND	ND	ND	ND
Silver (Ag)	10	1	10	0.18	0.09	ND	0.437
Sodium (Na)	10	10	100	990	380	429	1,540
Thallium (Tl)	10	8	80	17	15	ND	49.9
Vanadium (V)	9	9	100	22	1.3	19.8	23.1
Zinc (Zn)	10	10	100	73	19	50.7	104

ND Not Detected

Note: The maximum detected concentration is considered the background value for comparative purposes in this report.

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Table 2.3-2 Summary of Background Subsurface Soil Results

Analyte	Number of Samples	Number of Detections	Percent Detections	Arithmetic Mean (µg/g)	Standard Deviation	Minimum Detection (µg/g)	Maximum Detection (µg/g)
Aluminum (Al)	10	10	100	14,000	6,000	5,530	25,200
Antimony (Sb)	10	1	10	4.4	2.6	ND	11.9
Arsenic (As)	10	10	100	15	12	2.97	40.3
Barium (Ba)	10	10	100	220	94	130	423
Beryllium (Be)	10	10	100	0.70	0.24	0.401	1.21
Cadmium (Cd)	10	3	30	0.28	0.17	ND	0.601
Calcium (Ca)	10	10	100	12,000	69,000	32,100	252,000
Chromium (Cr)	10	10	100	21	11	8.12	48.5
Cobalt (Co)	10	10	100	5.8	1.9	2.12	8.59
Copper (Cu)	10	10	100	14	5.8	7.23	27.5
Iron (Fe)	10	10	100	14,000	5,200	6,140	24,300
Lead (Pb)	10	10	100	9.5	4.3	5.46	18.6
Magnesium (Mg)	10	10	100	12,000	2,200	8,950	15,300
Manganese (Mn)	10	10	100	290	110	166	474
Mercury (Hg)	10	9	90	0.05	0.04	ND	0.143
Nickel (Ni)	10	10	100	17	5.5	10.1	27.9
Potassium (K)	10	10	100	35	1,000	2,360	4,840
Selenium (Se)	10	1	10	0.02	0.07	ND	0.208
Silver (Ag)	10	0	0	ND	ND	ND	ND
Sodium (Na)	10	10	100	3,000	18	605	5,610
Thallium (Tl)	10	9	90	18	11	ND	33.9
Vanadium (V)	10	10	100	36	17	15.7	62.6
Zinc (Zn)	10	10	100	65	32	36.1	144

ND Not Detected
µg/g micrograms per gram

Note: The maximum detected concentration is considered the background value for comparative purposes in this report.

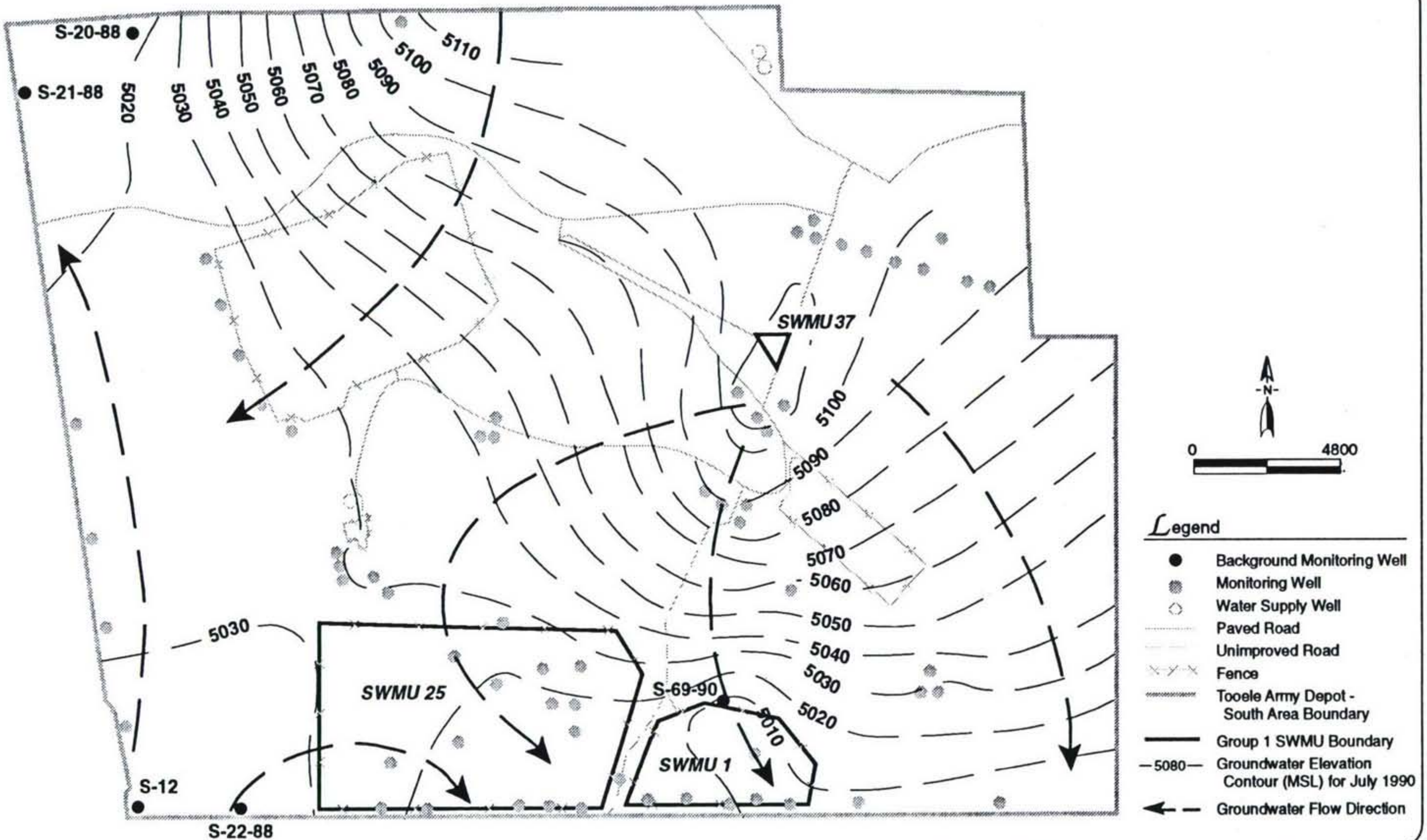

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Figure 2.3-2
Locations of Monitoring Wells Used for the Evaluation of Background Groundwater at TEAD-S

Tooele Army Depot - South Area
Prepared by: Ebasco Services Incorporated

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Table 2.3-3 Concentrations of Dissolved Metals and Anions in Background Groundwater at TEAD-S

Analyte	Background Concentration (μg/l)*
Dissolved Metals	
Antimony (Sb)	65.8
Arsenic (As)	420.0
Barium (Ba)	NA***
Beryllium (Be)	ND(5.0)
Cadmium (Cd)	ND(4.01)
Chromium (Cr)	9.26
Copper (Cu)	20.4
Lead (Pb)	24.0
Mercury (Hg)	ND(0.243)
Nickel (Ni)	60.8
Selenium (Se)	13.1
Silver (Ag)	ND(4.6)
Thallium (Tl)	ND(6.99)
Vanadium (V)	NA**
Zinc (Zn)	1,400
Anions	
Chloride (Cl)	36,000,000
Fluoride (F)	2,600
Nitrate+Nitrite (NIT)	11,400
Sulfate (SO_4)	8,100,000

*	-	Background data assembled from filtered analyses from Wells S-20-88, S-21-88, S-69-90, S-12, and S-22-88 at TEAD-S from 1982 through 1990. Maximum concentrations detected were used to establish background levels.
**	-	Vanadium was not analyzed for in background groundwater samples except for one sample in Well S-69-90 which yielded a nondetection (< 11.0 μg/l).
***	-	Barium was not analyzed for in background groundwater samples except for one sample in Well S-20-88, which yielded a nondetection (<25.0 μg/l)
ND	-	Not Detected (detection limit); for anions the lowest detection limit reported was listed here.
NA	-	Not Analyzed

(beryllium, cadmium, mercury, silver, and thallium) were not detected in any background wells. In general, barium and vanadium were analyzed in only one sampling round in which the results were below the detection limit. Therefore, background values were not determined for these analytes.

2.3.2.2 Salinity and Total Dissolved Solids

Natural groundwater quality varies significantly in wells across TEAD-S and at SWMUs 1 and 25. Dramatic increases in sodium and chloride, and to a lesser extent magnesium and sulfate, have been observed along the groundwater flow path from upgradient to downgradient wells. (EBASCO 1993a; Hood, Price, and Waddell 1969)

These increases are probably controlled by changes in aquifer material as groundwater flows from coarse-grained alluvial deposits along the mountain flanks to clay- and silt-rich lacustrine deposits of the valley floor. Fine-grained deposits typically have a higher percentage of sodium and halogen species (chloride, fluoride, bromide) than coarse-grained deposits, and as groundwater flows through the finer-grained lacustrine deposits, ion exchange reactions substitute sodium for calcium and magnesium and release halogen ions to solution, thereby increasing the salinity of the groundwater.

Another factor controlling the salinity of groundwater is the desert climate at TEAD-S. TEAD-S has a negative water balance because of low annual rainfall and high evaporation potential. This situation results in the deposition of soluble salts in the unsaturated zone, which is evidenced by the salt crusts that are commonly visible on the ground surface. Rainfall and seasonal snowmelt transport dissolved salts to the water table, increasing the salinity of the groundwater.

To evaluate the spatial changes in groundwater chemistry Stiff diagrams were prepared and total dissolved solids (TDS) concentrations were calculated for each well. Stiff diagrams illustrate the relative concentrations of major cations and anions to create a so-called "fingerprint" of the water type. TDS concentrations are commonly used as a measure of water quality. These data are listed in Table 2.3-4 and displayed in Figure 2.3-3.

TDS concentrations at SWMUs 1 and 25 range from a low of 2,040 milligrams per liter (mg/l) in well S-69-90 (SWMU 1) to 29,000 mg/l in well S-98-92 (SWMU 25). Groundwater with TDS concentrations less than 1,000 mg/l is classified as fresh; concentrations between 1,000 mg/l and 20,000 mg/l as brackish, and concentrations greater than 20,000 mg/l as saline (Drever 1988). Based on this classification, shallow groundwater at SWMU 1 is brackish, with TDS

Table 2.3-4 Groundwater Quality at SWMUs 1 and 25

Monitoring Well	SWMU	TDS (mg/l)	Chloride (mg/l)	Fluoride (mg/l)	Sulfate (mg/l)	Nitrate + Nitrite (mg/l)
S-4	1	6,100*	1,500**	3.3	2,500*	0.64
S-5	1	7,700*	3,300**	4.4*	1,800*	0.00
S-6	25	22,000*	11,000**	12.0*	4,100*	0.13
S-7	25	9,800*	6,000**	4.8*	750	3.80
S-18-88	25	23,000*	10,000**	11.0*	5,300*	0.03
S-19-88	25	12,000*	5,000**	5.4*	3,900*	1.20
S-64-90	25	27,000*	14,000**	13.0*	4,400*	11.00*
S-65-90	25	8,500*	4,700**	5.0*	900	0.02
S-66-90	25	8,000*	3,700**	4.1*	1,600*	0.20
S-67-90	25	26,000*	12,000**	12.0*	5,200*	560.00*
S-68-90	25	12,000*	4,800**	5.8*	3,000*	7.60
S-69-90	1	2,040*	530**	1.2	640	0.00

TDS - Total dissolved solids. Value was calculated as the sum of major cations and anions
* - Exceeds State of Utah Primary Drinking Water Standard: TDS=2000 mg/l, Fluoride=4.0 mg/l, Sulfate=1000 mg/l, nitrate + nitrite=10 mg/l
** - Exceeds State of Utah Secondary Drinking Water Standard: Chloride=250 mg/l

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Table 2.3-4 Groundwater Quality at SWMUs 1 and 25

Monitoring Well	SWMU	TDS (mg/l)	Chloride (mg/l)	Fluoride (mg/l)	Sulfate (mg/l)	Nitrate + Nitrite (mg/l)
S-70-90	1	9,600*	4,100**	5.3*	2,100*	2.70
S-71-90	1	9,700*	2,600**	4.3*	3,000*	1400.00*
S-93-92	1	4,400*	820**	2.3	2,200*	0.04
S-95-92	25	7,400*	2,000**	4.2*	2,900*	0.04
S-96-92	1	4,300*	1,400**	2.3	1,500*	0.03
S-97-92	1	12,000*	6,000**	6.2*	2,300*	29.00*
S-98-92	25	29,000*	15,000**	15.0*	5,200*	52.00*
S-99-92	25	14,000*	6,600**	6.4*	3,200*	24.00*
S-100-92	25	2,900*	1,200**	1.7	890	1.10
S-101-92	25	13,000*	7,700**	5.7*	2,000*	8.80
S-102-92	25	13,000*	7,100**	6.6*	2,200*	9.60

TDS - Total dissolved solids. Value was calculated as the sum of major cations and anions
* - Exceeds State of Utah Primary Drinking Water Standard: TDS=2000 mg/l, Fluoride=4.0 mg/l, Sulfate=1000 mg/l, nitrate + nitrite=10 mg/l
** - Exceeds State of Utah Secondary Drinking Water Standard: Chloride=250 mg/l

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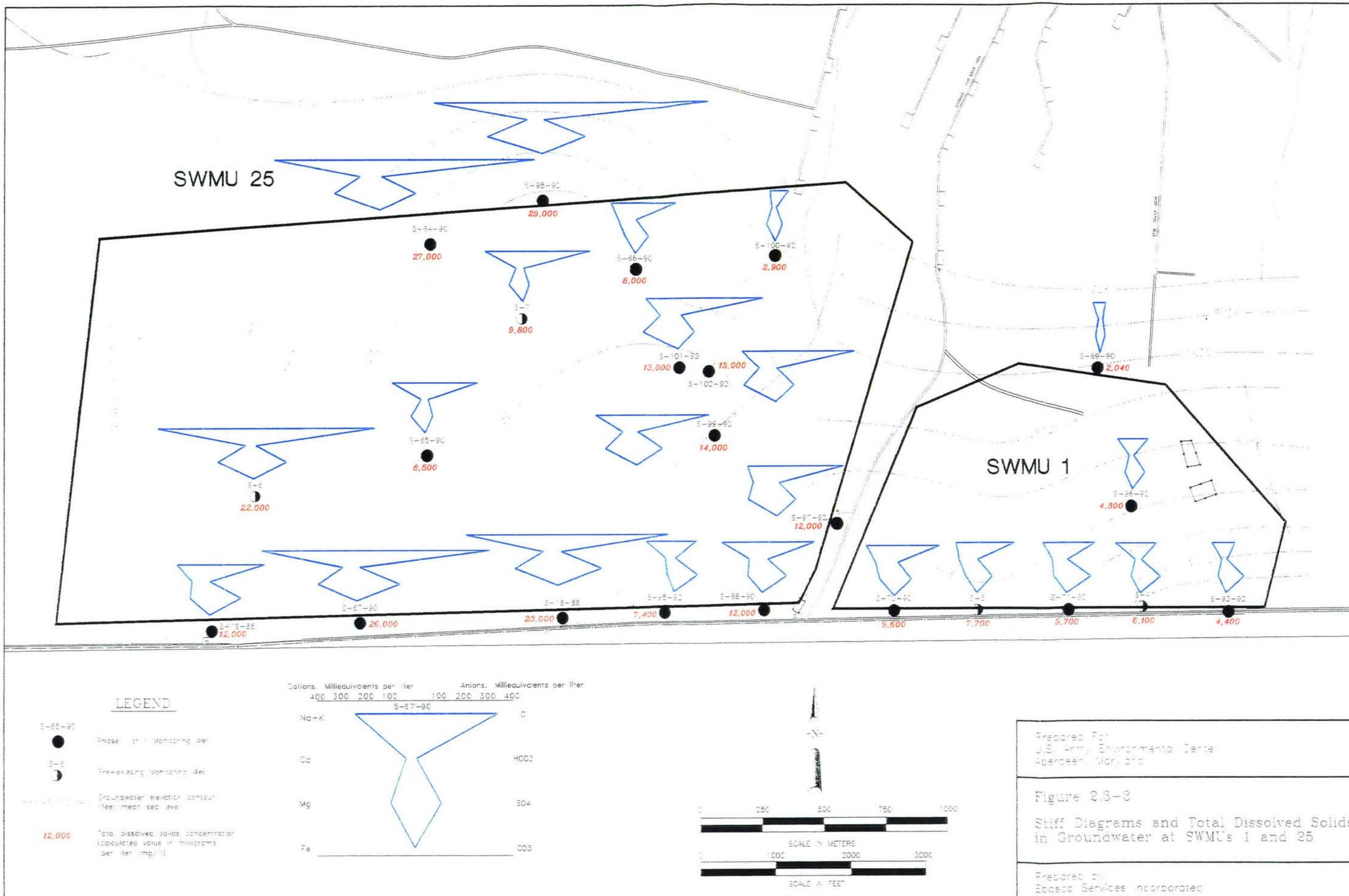


Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 2.3-3

Stiff Diagrams and Total Dissolved Solids in Groundwater at SWMUs 1 and 25

Prepared by:
Ebasco Services Incorporated

concentrations ranging from 2,040 mg/l (well S-69-90) to 9,700 mg/l (well S-71-90). Shallow groundwater at SWMU 25 is brackish to saline, with TDS concentrations ranging from 2,900 mg/l (well S-100-92) to 29,000 mg/l (well S-98-92). Concentrations of TDS greater than 20,000 mg/l occurred in wells S-64-90, S-98-92, S-6, S-67-96, and S-18-88.

Comparison of TDS and anion concentrations from SWMU 1 and 25 wells to regulatory standards show that TDS levels exceed State of Utah primary maximum contaminant level (MCL) standards for drinking water (2,000 mg/l) in all 23 wells. Levels of fluoride exceed the Utah standard (4.0 mg/l) in 18 of the 23 wells, with one of these exceedances more than three times the MCL or 15 mg/l. Standards for sulfate (1000 mg/l) are exceeded in 19 wells, up to approximately five times the MCL or 5,300 mg/l. The nitrate + nitrite MCL of 10 mg/l is exceeded in six wells, up to 140 times the MCL. Nitrate and nitrite occur naturally in groundwater, but elevated levels of theses anions in groundwater at these SWMUs may be indicative of potential chemical breakdown products associated with explosive compounds. The levels of naturally occurring analytes indicate that the groundwater beneath SWMUs 1 and 25 is nonpotable.

3.0 RFI-PHASE II FIELD INVESTIGATION

The RFI-Phase II field program conducted at SWMUs 1 and 25 was designed to characterize the environmental setting, define the sources and the nature and extent of contamination, and identify actual and potential receptors. The field investigation at SWMU 37 was intended to determine the presence or absence of contamination only. Data obtained under previous investigations were used to plan the RFI-Phase II field program and have been incorporated into the contamination assessment. However, the human health and ecological risk assessments consider only the results of the RFI-Phase II program in the interest of evaluating contemporaneous, comparable data.

The RFI-Phase II field program was conducted in accordance with the USATHAMA Quality Assurance Program (1990) and the USATHAMA Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports (1987). It included the following activities:

- Ecological investigations
- Air quality monitoring
- Unexploded ordnance locating and explosive risk determination
- Chemical agent monitoring
- Soil gas sampling
- Soil and solid waste sampling
- Well installation, development, and monitoring
- Groundwater sampling
- Aquifer testing

3.1 ECOLOGICAL INVESTIGATIONS

Ecological investigations at SWMUs 1, 25, and 37 included vegetation mapping and key species identification to identify potential ecological receptors and their ranges. The area of investigation was broadened beyond the SWMU boundaries to include all of TEAD-S to account for mobile species. Vegetation mapping for these SWMUs was conducted in fall and winter 1991, and a final field check was conducted in summer 1992. The facility-wide map was completed in the summer of 1993. Key species were identified by combining field observations from fall and winter 1991 with data presented in previous investigations.

3.1.1 Vegetation Mapping

A vegetation map was prepared for SWMUs 1, 25, and 37, and the surrounding areas. This map provides a basis for characterizing wildlife habitat, analyzing potential contaminant migration

pathways, and identifying potential receptors. Initially, the investigation included a review of the following existing vegetation and soil mapping data:

- SCS soil maps and range site maps; particular reference was made to the unpublished "Soil and Range Survey of the Tooele Army Depot" (SCS no date)
- BLM ecological site mapping information; areas in proximity to TEAD-S were investigated and mapped in association with the Tooele Grazing Draft Environmental Impact Statement (BLM 1983)
- U.S. Forest Service Vegetation and Environmental Features of Forest and Range Ecosystems (Garrison et al. 1977); descriptions of sagebrush and desert shrub ecosystems were compared to areas in proximity to TEAD-S.

The classification schemes employed in these existing maps emphasized range management requirements, and the classifications were based on assessments of potential vegetation. These schemes did not necessarily reflect man-made disturbances and natural disturbance regimes that create various successional stages of the potential climax vegetation.

To better reflect actual conditions, field biologists developed a vegetation map of TEAD-S during the RFI-Phase II using a modified classification system related to broad ecological requirements (i.e., habitats). To create the map, observational field surveys were conducted. From strategic topographic highs, vegetation types that were apparent from each location were identified. Where numerous or small-sized plants were present, the species were individually identified. Generally, contacts between vegetation types were transitional but could be identified on aerial photographs with adequate ground-truthing. The boundaries between habitat areas were drawn directly on color infrared aerial photographs taken in June 1987. The mapped boundaries were digitized and transferred onto the base map using an AutoCADD system (Plate 3).

3.1.2 Key Species Identification

Key and sensitive species related to SWMUs 1, 25, and 37 were identified using wildlife surveys. The area of investigation was broadened beyond the boundaries of the SWMUs because of the mobility of species typical of Rush Valley. All species present in the valley can be considered as potential receptors at TEAD-S. These key species will be considered in the ecological risk assessment.

A key species list was compiled by combining data from the RFI-Phase II of known releases units (SEC Donohue 1992) with new field data acquired during the fall and winter of 1991. The resultant species list is provided in Appendix G. The new field data included information on large mammal, raptor, and small bird populations.

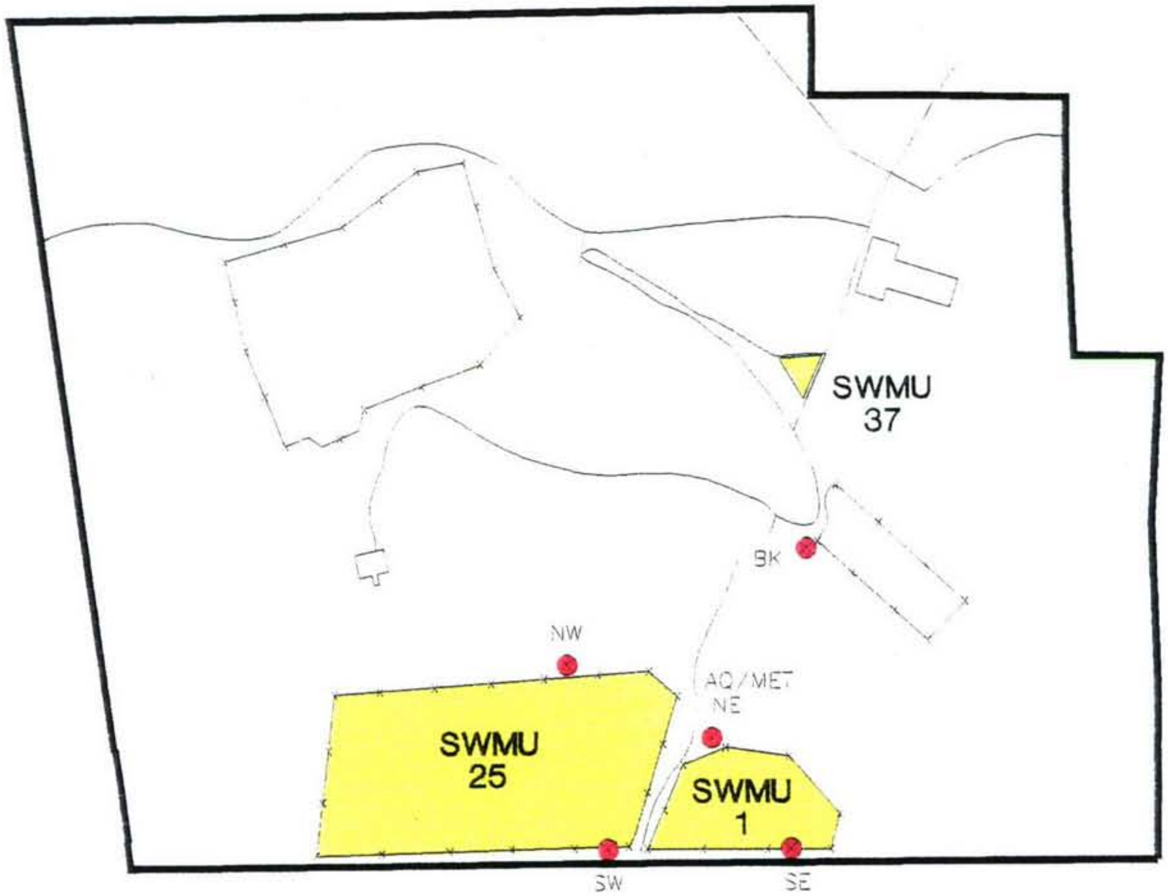
The wildlife surveys were conducted to document species and trophic groups in the SWMUs and to identify any threatened or endangered (sensitive) species. The surveys were performed along transects at the boundaries and inside the SWMUs. Species were identified and their habitat usage was recorded on field data sheets and later compiled with data from previously conducted surveys.

Considerable qualitative data on the flora and fauna of Rush Valley is available in the published literature (SCS no date; BLM 1988; UDOW 1993). These literature sources, along with discussions with BLM biologists and state wildlife coordinators to re-affirm the adequacy of the species identified, were used to review the adequacy of the compiled species list. The results of this effort are presented in Sections 5.2.2.2 and 5.2.2.3.

3.2 AIR QUALITY MONITORING

Air quality monitoring was conducted at TEAD-S between August 10 and September 2, 1992, in order to support the evaluation of the air pathway in the human health risk assessment of SWMUs 1 and 25. Five air quality sampling locations and one meteorological monitoring site were selected (Figure 3.2-1). Sampling sites NW and SW were located north-northwest (upwind) and south-southeast (downwind) of the eastern portion of SWMU 25, respectively, in accordance with anticipated prevailing wind directions observed using long-term TEAD-S meteorological data. Sites NE and SE were located north-northwest and south-southeast of SWMU 1 respectively, also in accordance with the prevailing wind direction. The NE station was also used for meteorological monitoring. Actual wind directions observed during the monitoring program were very close to the projected wind directions. Figure 3.2-2 shows the composite windrose compiled for each of the 24-hour monitoring periods. Site BK was located north of SWMU 1 (within SWMU 9) to evaluate possible effects of other potential sources on analyte concentrations in SWMUs 1 and 25.

Target analytes monitored included total suspended particulates (TSP), metals (aluminum, arsenic, barium, chromium, lead, magnesium, nickel, sodium, and zinc), volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). VOC and SVOC target compounds were



LEGEND

- Air Sampling Stations
- Location of Group 1 SWMUs
- Roads
- Fence
- Tooele Army Depot – South Area Boundary

SOLID WASTE MANAGEMENT UNITS

1. East Demilitarization Area Disposal Pits
25. West Demilitarization Area/Disposal Pits
37. Slag Piles and Bomb Fragments

-N-

0 2000 4000 6000

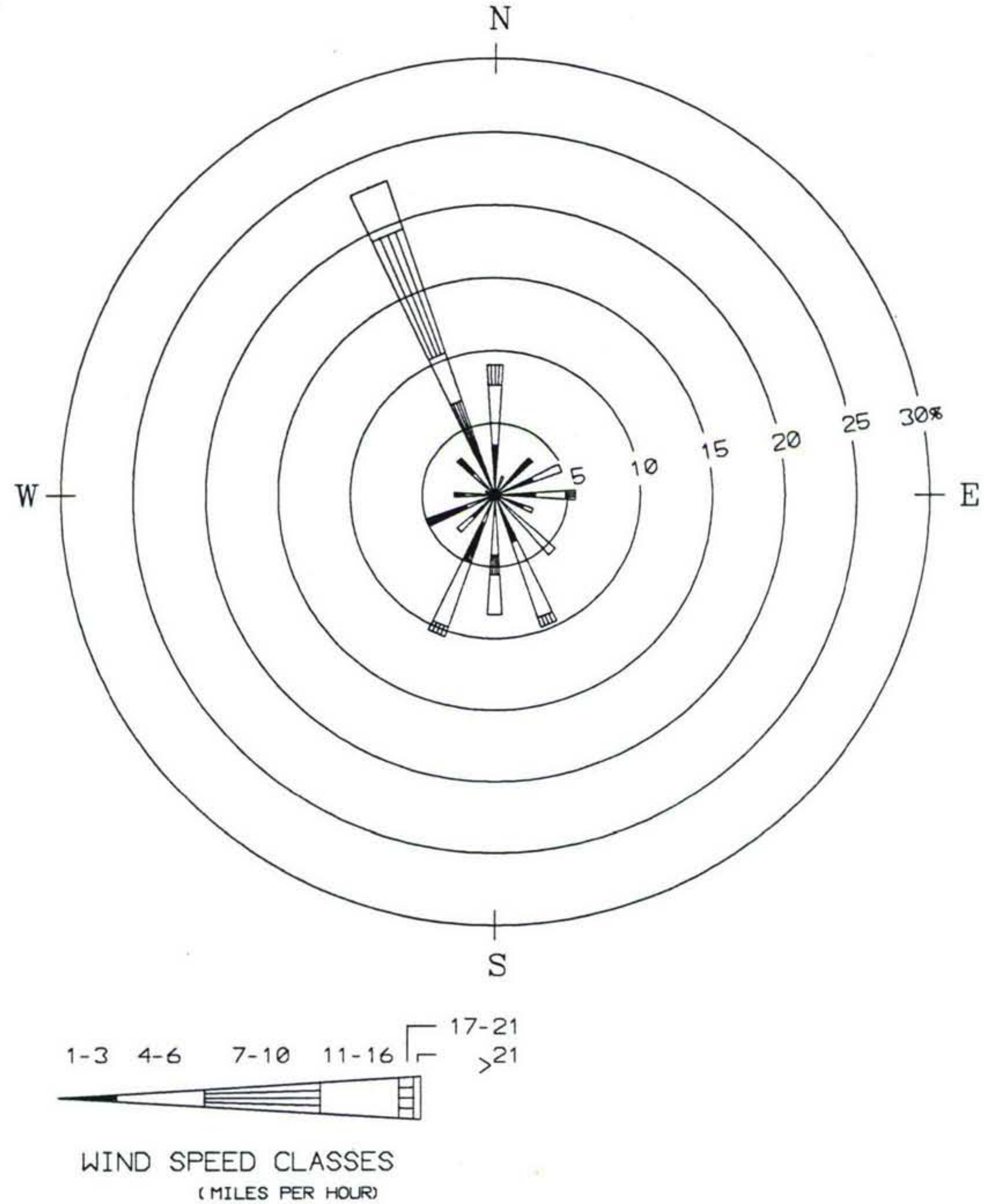
SCALE IN FEET

Source: NUS Corporation 1987
EBASCO Field Measurement

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.2-1
Air Monitoring Site Locations
August 10 – September 2, 1992
Air Quality Studies

Prepared by:
Ebasco Services Incorporated



Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.2-2

Overall Windrose
August 10 - September 2, 1992

Prepared by:
Ebasco Services Incorporated

selected using the results of previous soil studies conducted at Tooele, as well as standard chemical analyte lists. The list of target analytes and the detection limit for each is shown in Table 3.2-1.

In sampling, the field crew's objective was to select days or events where meteorological conditions would be most favorable for higher contaminant levels. Samples collected under these conditions would be representative of worst case conditions, adding a conservative bias to the contamination assessment. These conditions included warm daytime temperatures and nighttime inversions for VOCs and SVOCs, and moderate to strong winds for metals, which are generally transported with dust particles. Strong-wind events were also selected for SVOCs since these compounds can also adhere to dust particles. For the most part, these conditions were met for the selected sampling days. The prevailing wind during the monitoring period was from the north-northwest (Figure 3.2-2). All wind directions and wind speeds, however, were represented on individual sampling days as shown in the daily windroses (Appendix J).

Samples were collected over a 3-week period. Following each sampling event, field crews reviewed the corresponding meteorological data to evaluate whether the samples could be considered representative of reasonable worst-case conditions. Eight sample events for SVOCs, seven sample events for TSP and VOCs, and six sample events for metals were selected as representative over the 3-week period.

Total suspended particulates (TSP) and metals were collected using 4-inch diameter quartz fiber filters. The filters were mounted in General Metal Works, Inc. Model PS-1 sampling Modules. A battery-powered diaphragm pump equipped with a flowmeter and flow control valve was used for sample aeration. The filters were weighed before and after sampling to determine mass loading; filter conditioning was performed prior to pre and post weighings.

VOCs were sampled using passivated canisters and Xontech, Inc. pumps. The canisters were cleaned and evacuated prior to use. The Xontech pump pneumatic components were cleaned and tested prior to field installation. The pumps provided a constant flow rate during the collection period.

SVOCs were sampled using PUF/XAD sampling cartridges. The cartridges were aerated using flow controlled personal sampling pumps.

Table 3.2-1 • Analyte List and Detection Limits, Page 1 of 7

Compound	Air Samples	Soil Samples	Water Samples
Volatiles	mg/m^3	µg/g	µg/l
Chloromethane	0.06	0.96	3.2
Bromomethane	0.06	0.26	5.8
Vinyl Chloride	0.06	1.8	2.6
Chloroethane	0.06	0.64	1.9
Methylene Chloride	0.14	4.4	2.3
Acetone	0.20	3.3	13.0
Carbon Disulfide	0.06	0.60	0.50
1,1-Dichloroethene	0.06	0.49	0.50
1,1-Dichloroethane	0.06	0.27	0.68
1,2-Dichloroethene (Total)	0.06	0.32	0.50
Chloroform	0.06	0.24	0.50
1,2-Dichloroethane	0.06	0.32	0.50
2-Butanone	0.20	4.3	6.4
1,1,1-Trichloroethane	0.06	0.20	0.50
Carbon Tetrachloride	0.06	0.31	0.58
Vinyl Acetate	0.06	1.0	8.3
Bromodichloromethane	0.06	0.20	0.59
1,2-Dichloropropane	0.06	0.53	0.50
cis-1,3-Dichloropropene	0.06	0.60	0.58
Trichloroethene	0.06	0.23	0.50
Dibromochloromethane	0.06	0.50	0.67
1,1,2-Trichloroethane	0.06	0.33	1.2
Benzene	0.06	0.10	0.50
trans-1,3-Dichloropropene	0.06	0.60	0.70
Bromoform	0.06	0.20	2.6
4-Methyl-2-pentanone	0.20	0.63	3.0

NA - Not analyzed
µg/l - Microgram per liter
mg/m^3 - Milligrams per cubic meter
µg/g - Microgram per gram
TIC - Tentatively Identified Compound
$\mu g/m^3$ - Micrograms per cubic meter

T2G1 7.94.jb

Table 3.2-1 • Analyte List and Detection Limits, Page 2 of 7

Compound	Air Samples	Soil Samples	Water Samples
Volatiles (continued)	mg/m^3	µg/g	µg/l
2-Hexanone	0.20	1.0	3.6
Tetrachloroethene	0.20	0.16	1.6
Toluene	0.06	0.10	0.50
1,1,2,2-Tetrachlorethane	0.06	0.20	0.51
Chlorobenzene	0.06	0.10	0.50
Ethylbenzene	0.06	0.19	0.50
Styrene	0.06	0.60	0.50
Xylenes (Total)	0.06	0.78	0.84
1,2-Dibromoethane	0.06	TIC	TIC
Benzyl Chloride	0.06	TIC	TIC
1,2- Dichlorobenzene	0.06	0.20	10.0
1,3- Dichlorobenzene	0.06	0.14	10.0
1,4-Dichlorobenzene	0.06	0.20	10.0
1,2,4-Trichlorobenzene	0.20	NA	NA
Semivolatiles	$\mu g/m^3$	µg/g	µg/l
Phenol	20.0	0.052	9.2
bis (2-Chloroethyl) ether	20.0	0.360	1.9
2-Chlorophenol	20.0	0.055	0.99
1,3-Dichlorbenzene	NA	0.042	1.7
1,4-Dichlorobenzene	NA	0.034	1.7
Benzyl alcohol	20.0	0.032	0.72
1,2-Dichlorobenzene	NA	0.042	1.7
2-Methylphenol	20.0	0.098	3.9
bis (2-Chloroisopropyl) ether	NA	0.440	5.3
4-Methylphenol	20.0	0.240	0.52
N-Nitroso-di-n-propylamine	NA	1.10	4.4

NA - Not analyzed
µg/l - Microgram per liter
mg/m^3 - Milligrams per cubic meter
µg/g - Microgram per gram
TIC - Tentatively Identified Compound
$\mu g/m^3$ - Micrograms per cubic meter

Table 3.2-1 • Analyte List and Detection Limits, Page 3 of 7

Compound	Air Samples	Soil Samples	Water Samples
Semivolatiles (continued)	μg/m^3	μg/g	μg/l
Hexachloroethane	20.0	1.80	1.5
Nitrobenzene	20.0	1.80	0.50
Isophorone	20.0	0.390	4.8
2-Nitrophenol	20.0	1.10	3.7
2,4-Dimethylphenol	20.0	3.00	5.8
Benzoic acid	100.0	3.10	13.0
bis (2-Chloroethoxy) methane	20.0	0.190	1.5
2,4-Dichlorophenol	20.0	0.065	2.9
1,2,4-Trichlorobenzene	NA	0.220	1.8
Naphthalene	20.0	0.740	0.50
4-Chloroaniline	20.0	0.630	7.3
Hexachlorobutadiene	20.0	0.970	3.4
3-Methyl-4-Chlorophenol	20.0	0.930	4.0
2-Methylnapthalene	20.0	0.032	1.7
Hexachlorocyclopentadiene	20.0	0.520	8.6
2,4,6-Trichlorophenol	20.0	0.061	4.2
2,4,5-Trichlorophenol	100.0	0.490	5.2
2-Chloronaphthalene	20.0	0.240	0.50
2-Nitroaniline	20.0	3.10	4.3
Dimethylphthalate	20.0	0.063	1.5
Acenaphthylene	20.0	0.033	0.50
2,6-Dinitrotoluene	20.0	0.320	0.79
3-Nitroaniline	20.0	3.00	4.9
Acenaphthene	20.0	0.041	1.7
2,4-Dinitrophenol	100.0	4.70	21.0

NA - Not analyzed
μg/l - Microgram per liter
mg/m^3 - Milligrams per cubic meter
μg/g - Microgram per gram
TIC - Tentatively Identified Compound
μg/m^3 - Micrograms per cubic meter

Table 3.2-1 • Analyte List and Detection Limits, Page 4 of 7

Compound	Air Samples	Soil Samples	Water Samples
Semivolatiles (continued)	µg/m³	µg/g	µg/l
4-Nitrophenol	100.0	3.30	12.0
Dibenzofuran	20.0	0.038	1.7
2,4-Dinitrotoluene	20.0	1.40	4.5
Diethylphthalate	20.0	0.240	2.0
4-Chlorophenyl-phenyl ether	20.0	0.170	5.1
Fluorene	20.0	0.065	3.7
4-Nitroaniline	20.0	3.10	5.2
4,6-Dinitro-2-methylphenol	100.0	0.800	17.0
N-nitrosodiphenylamine	NA	0.290	3.0
4-Bromophenyl-phenyl ether	20.0	0.041	4.2
Hexachlorobenzene	20.0	0.008	1.6
Pentachlorophenol	100.0	0.760	18.0
Phenanthrene	20.0	0.032	0.50
Anthracene	20.0	0.710	0.50
Di-n-butylphthalate	NA	1.30	3.7
Fluoranthene	20.0	0.032	3.3
Pyrene	20.0	0.083	2.8
Butylbenzylphthalate	20.0	1.80	3.4
3,3'-Dichlorobenzidine	100.0	1.60	12.0
Benzo(a)anthracene	20.0	0.041	1.6
Chrysene	20.0	0.032	2.4
bis (2-Ethylhexyl)phthalate	20.0	0.480	4.8
Di-n-octylphthalate	20.0	0.230	15.0
Benzo(b)fluoranthene	20.0	0.310	5.4
Benzo(k)fluoranthene	20.0	0.130	0.87
Benzo(a)pyrene	20.0	1.20	4.7

NA - Not analyzed
µg/l - Microgram per liter
mg/m³ - Milligrams per cubic meter
µg/g - Microgram per gram
TIC - Tentatively Identified Compound
µg/m³ - Micrograms per cubic meter

Table 3.2-1 • Analyte List and Detection Limits, Page 5 of 7

Compound	Air Samples	Soil Samples	Water Samples
Semivolatiles (continued)	µg/m³	µg/g	µg/l
Indeno (1,2,3-cd)pyrene	20.0	2.40	8.6
Dibenz(a,h)anthracene	20.0	0.310	6.5
Benzo(g,h,i)perylene	20.0	0.180	6.1
PCBs	µg/m³	µg/g	µg/l
Aroclor-1016	2.0	0.1000	0.16
Aroclor-1221	2.0	0.1000	0.16
Aroclor-1232	2.0	0.1000	0.16
Aroclor-1242	2.0	0.1000	0.19
Aroclor-1248	2.0	0.1000	0.19
Aroclor-1254	2.0	0.0479	0.19
Aroclor-1260	2.0	0.0479	0.19
Explosives		µg/g	µg/l
1,3-Dinitrobenzene (13DNB)	NA	0.504	0.6110
1,3,5-Trinitrobenzene (135TNB)	NA	0.922	0.4490
2,4-Dinitrotoluene (24DNT)	NA	2.50	0.0637
2,6-Dinitrotoluene (26DNT)	NA	2.00	0.0738
2,4,6-Trinitrotoluene (246TNT)	NA	2.00	0.6350
Cyclotetramethylenetetranitramine (HMX)	NA	2.00	1.210
Hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX)	NA	1.28	1.170
N-Methyl-N-2,4,6-tetranitroaniline (Tetryl)	NA	2.11	2.490
Nitrobenzene (NB)	NA	1.14	0.6450
Agent Breakdown Products		µg/g	µg/l
Ethylmethyl phosphonic acid (EMPA)	NA	2.11	100.0
Fluoroacetic acid	NA	2.0	100.0
Isopropylmethyl phosphonic acid (IMPA)	NA	2.11	100.0
Methyl phosphonic acid (MPA)	NA	2.0	128.0
Thiodiglycol	NA	3.94	48.8

NA - Not analyzed
µg/l - Microgram per liter
mg/m³ - Milligrams per cubic meter
µg/g - Microgram per gram
TIC ³ - Tentatively Identified Compound
µg/m³ - Micrograms per cubic meter

Table 3.2-1 • Analyte List and Detection Limits, Page 6 of 7

Compound	Air Samples	Soil Samples	Water Samples
Metals	$\mu g/m^3$	$\mu g/g$	$\mu g/l$
Aluminum	2.18	11.2	141.0
Antimony	NA	19.6	3.03
Arsenic	0.180	2.50	2.54
Barium	0.360	3.29	5.00
Beryllium	NA	0.427	5.00
Cadmium	NA	1.20	4.01
Calcium	NA	25.3	500.0
Chromium	0.360	1.04	6.02
Cobalt	NA	2.50	25.0
Copper	NA	2.84	8.09
Iron	NA	6.66	38.8
Lead	0.110	0.467	1.26
Magnesium	7.27	10.1	500.0
Manganese	NA	9.87	2.75
Mercury	NA	0.050	0.243
Nickel	0.720	2.74	34.3
Potassium	NA	131.0	375.0
Selenium	NA	0.449	3.02
Silver	NA	0.803	4.60
Sodium	7.27	38.7	500.0
Thallium	NA	34.3	6.99
Vanadium	NA	1.41	11.0
Zinc	0.720	2.34	21.1

NA - Not analyzed
$\mu g/l$ - Microgram per liter
mg/m^3 - Milligrams per cubic meter
$\mu g/g$ - Microgram per gram
TIC - Tentatively Identified Compound
$\mu g/m^3$ - Micrograms per cubic meter

Table 3.2-1 • Analyte List and Detection Limits, Page 7 of 7

Compound	Air Samples	Soil Samples	Water Samples
Anions	$\mu g/m^3$	µg/g	µg/l
Bromide	NA	NA	1000.0
Chloride	NA	NA	2120.0
Fluoride	NA	NA	1230.0
Cyanide	NA	NA	6100.0
Bicarbonate	NA	NA	10,000.0
Sulfate	NA	NA	10.0
Nitrite and Nitrate	NA	NA	NA
Total Suspended Particulates	**5 µg/m3**	**0.250**	**2.50**

NA - Not analyzed
µg/l - Microgram per liter
mg/m^3 - Milligrams per cubic meter
µg/g - Microgram per gram
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Sampling inlets for each type of media were located at a height of approximately 6.5 feet above ground level. All samplers were controlled using programmable timers to allow automated actuation.

Meteorological monitoring was performed using a portable meteorological monitoring system equipped with a datalogger. Parameters included wind speed, wind direction, ambient temperature and barometric pressure. The wind and temperature sensors were installed at a height of approximately 2 meters. The barometric pressure sensor was located in the datalogger enclosure. All sensors were professional grade instruments designed for air quality monitoring purposes. The datalogger provided summarized hourly averages and also computed sigma theta (wind direction fluctuation standard deviation).

All samplers and instruments were calibrated using certified standards and reference devices. TSP/metals, VOCs, and SVOC flow rates were determined at the beginning and end of each sampling period using mass flowmeters.

3.3 MUNITIONS DISPOSAL PIT INVENTORY AND EXPLOSIVE RISK DETERMINATION

Demilitarization operations in SWMUs 1 and 25 were conducted in more than 200 pits and other disposal features scattered across the large areas of these SWMUS. Because a preliminary reconnaissance of these SWMUs showed that munitions parts and other demilitarization debris remained in and around these disposal features, it was necessary to examine and catalog this debris for the following purposes:

- Characterize potential sources of chemical contamination
- Plan surface soil sampling representative of the variety of disposal features in these SWMUs
- Determine if there is a physical hazard from unexploded ordnance

To provide data for these purposes, the field program included an inventory of the contents of many of these features and the surrounding area. However, to ensure that the inventory would be efficient and cost-effective, aerial photographs were used first to identify areas where pit 30

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characteristics might be uniform (Figures 3.3-1 and 3.3-2). The photographs were used to assign a unique number to each pit for use in documenting field observations and to aid in interpretation of historical use.

In areas where disposal features were tentatively grouped as similar, several of the disposal features, but not all, would be included in the inventory and considered representative of the entire group. Such groups were tentatively identified where aerial photographs showed clusters of disposal features of approximately the same size, shape, and orientation. Then transects were planned so that the field crew could reach examples of each group in an efficient way.

During the field survey, the pit inventory and explosive risk determination were performed concurrently through documentation of observations made along these preplanned transects. Seven transects in or near SWMU 1 (Figure 3.3-3) and eleven transects in or near SWMU 25 (Figure 3.3-4) were completed. (Transects T1 and T12 are located outside of SWMU 25 and 1 boundaries respectively.) Field observations were made at 151 of 213 disposal features identified in the aerial photographs. The results of the inventory confirmed that different pits within the tentatively identified groups were similar. These groups of disposal features are presented as the SWMU 1 and 25 source areas defined in Section 4.1 of this report.

Observations at each inventoried pit included whether the pit was open or closed, the presence of signs identifying any hazards, and an inventory of the pit contents. A global positioning system (GPS) was used to establish the longitude and latitude of each pit or other field location where observations were made. These data were used as the basis for the sampling location base maps. Photographs were taken to document the type and condition of munitions or other wastes observed during the survey (see Section 4.1).

For the explosive risk characterization of areas outside the disposal pits, records were maintained of UXO observed within a 20-ft radius of points spaced at approximately 500-ft intervals along each transect. This characterization was extended into areas where the photographs indicated little past activity so that all portions of the SWMUs were included in the assessment. The field crew added observation points as necessary to ensure that the final data set was representative of the types, condition, and number of UXO observed along the entire transect. The transects extended slightly beyond the SWMU boundaries in order to evaluate whether ground scatter associated with past demilitarization operations migrated beyond the SWMU fencelines. An inventory of the scattered munitions observed in areas outside the individual disposal features

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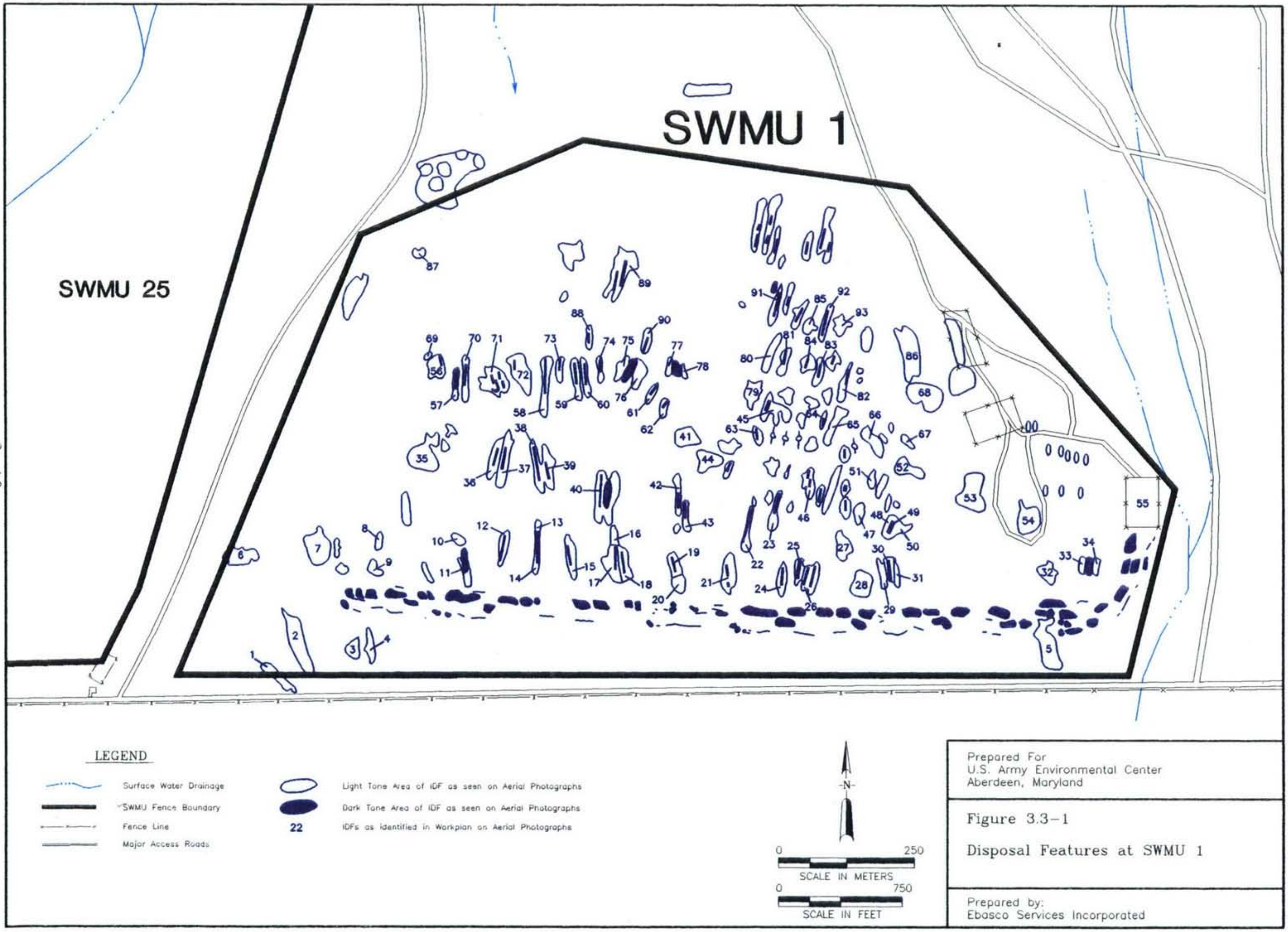
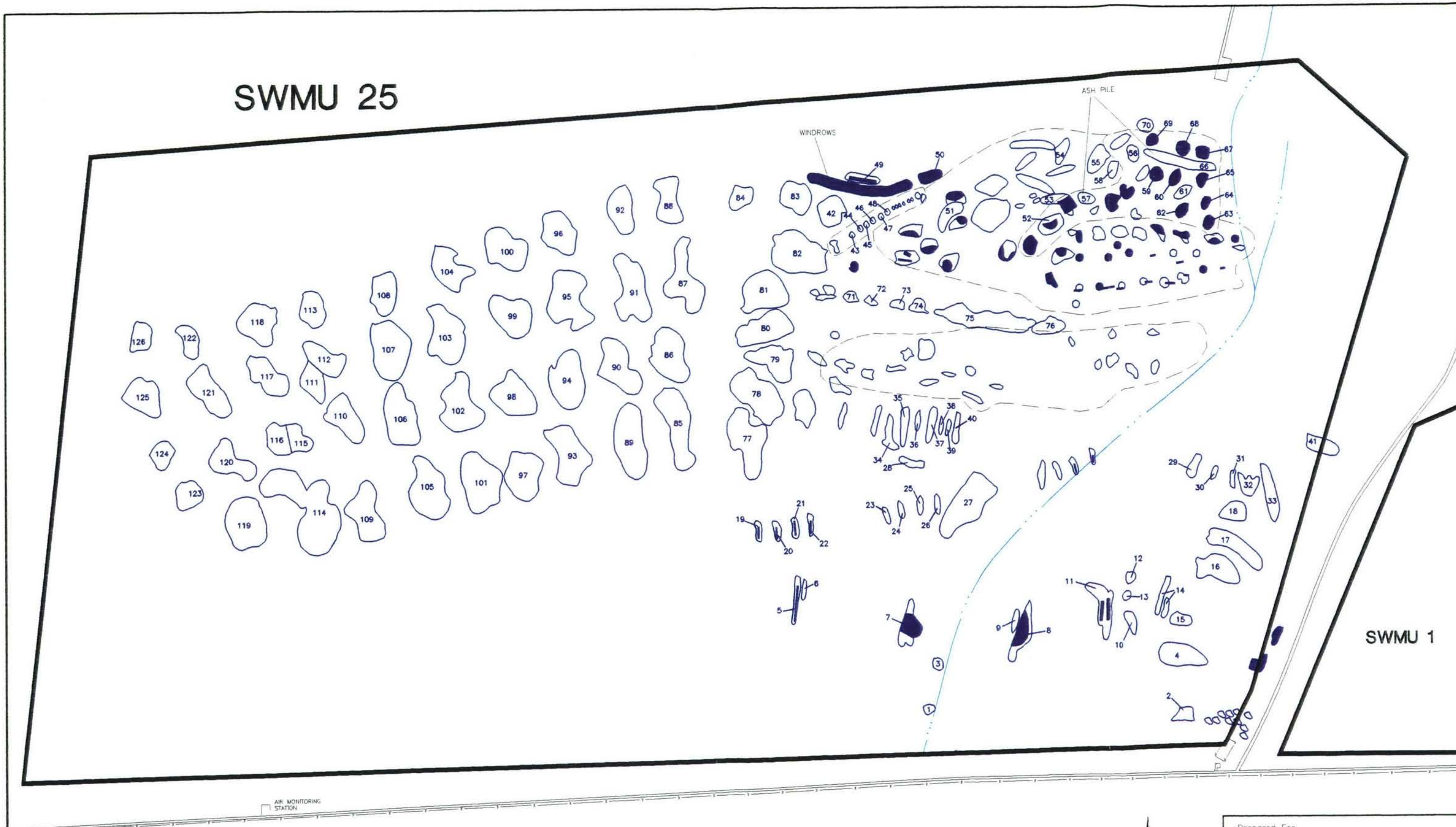


Figure 3.3-1

Disposal Features at SWMU 1



LEGEND

Surface Water Drainage	Light Tone Area of IDF as seen on Aerial Photographs
SWMU Fence Boundary	Dark Tone Area of IDF as seen on Aerial Photographs
Fence Line	22 IDFs as identified in Work Plan on Aerial Photographs
Major Access Roads	Activity Area as defined on Aerial Photographs

-N-

0 250
SCALE IN METERS
0 750
SCALE IN FEET

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.3-2

Disposal Features at SWMU 25

Prepared by:
Ebasco Services Incorporated

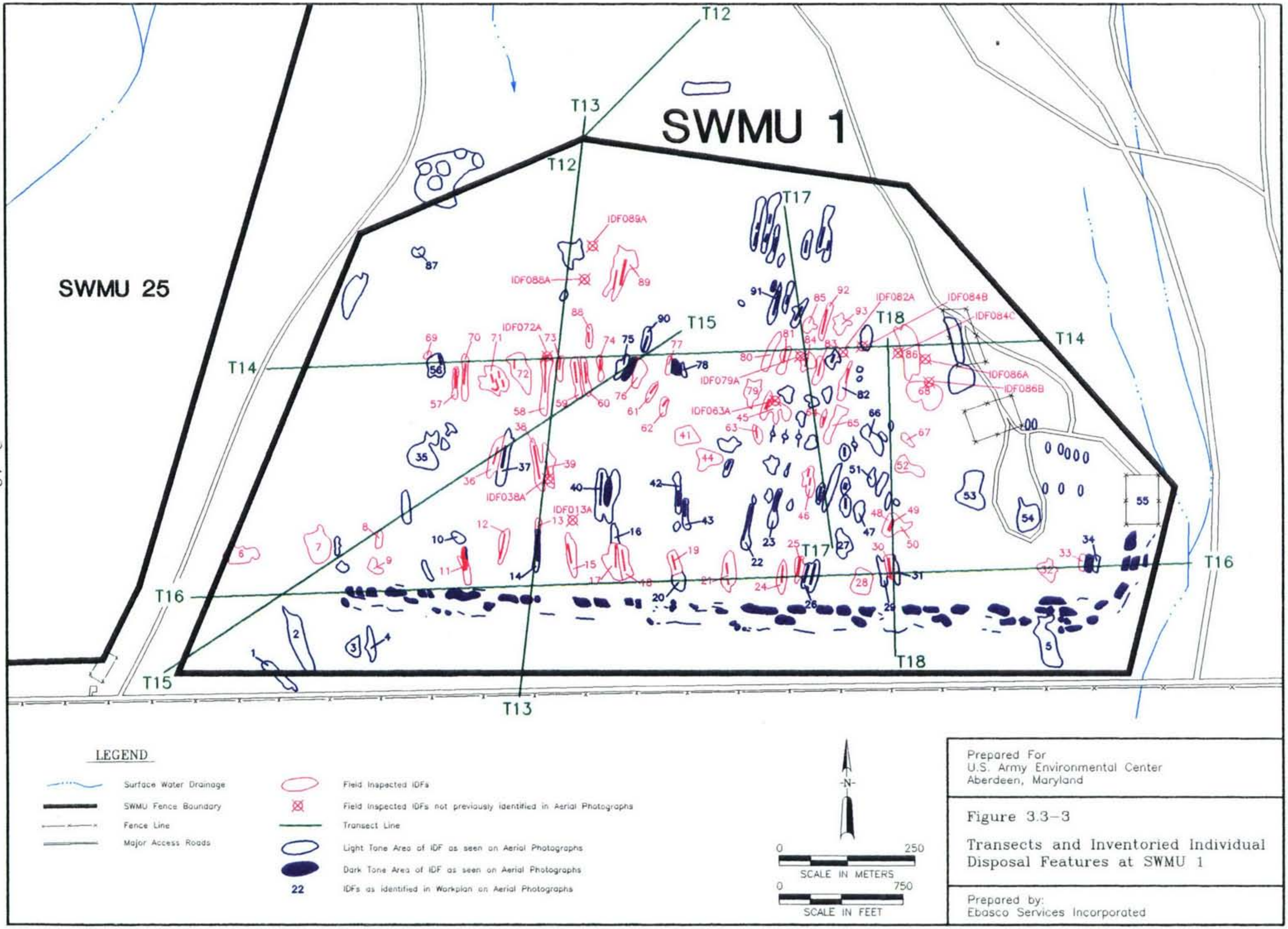
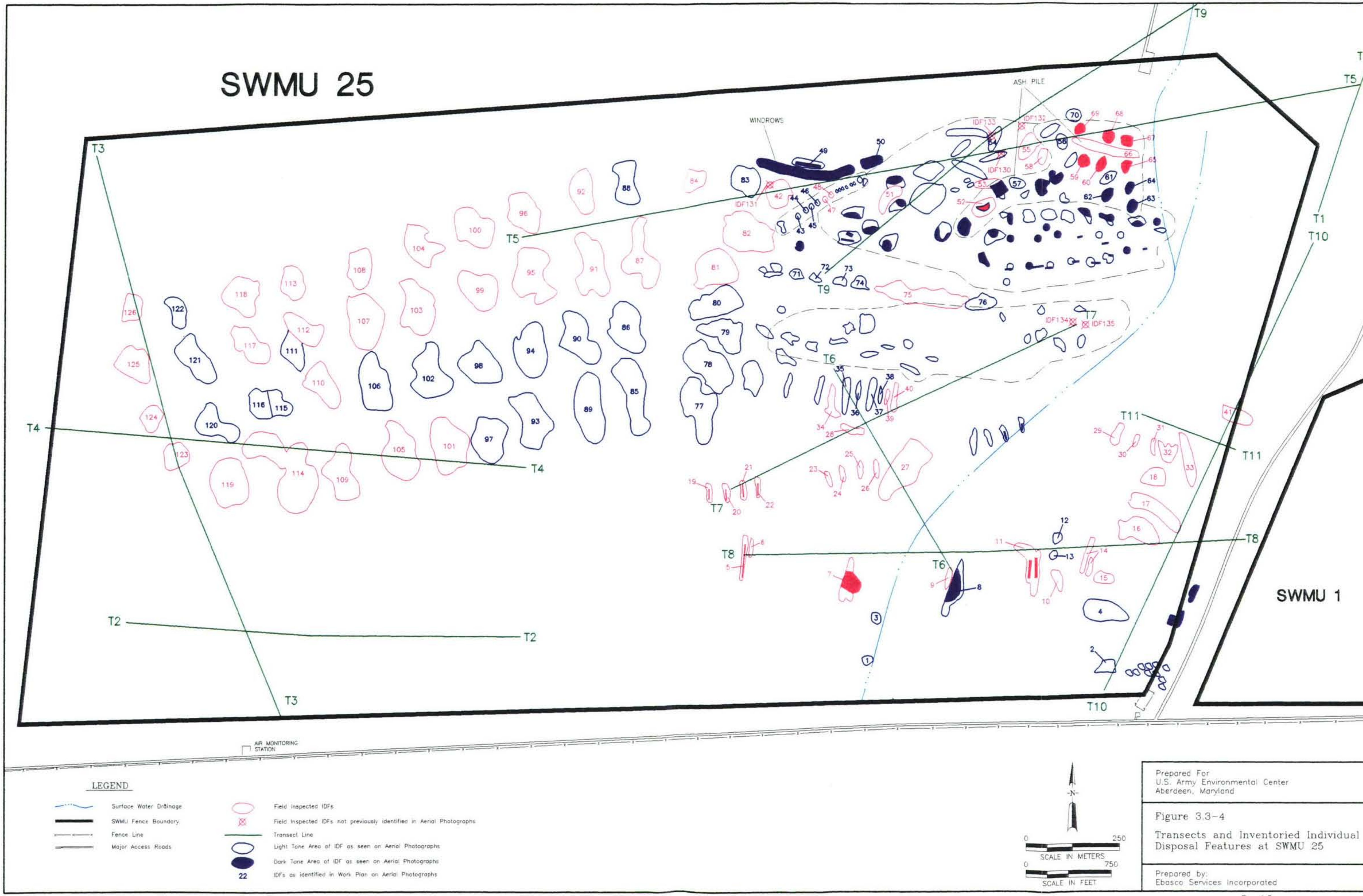


Figure 3.3-3

Transects and Inventoried Individual Disposal Features at SWMU 1



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.3-4

Transects and Inventoried Individual Disposal Features at SWMU 25

Prepared by:
Ebasco Services Incorporated

(IDFs), along the transects, were also recorded (see Section 4.1).

3.4 EXPLOSIVES SCREENING AND CHEMICAL AGENT MONITORING

Screening samples of soil were collected primarily as a safety measure. Sample splits for chemical agent screening were collected in all portions of SWMU 1. No agent screening was needed or performed during work at SWMUs 25 or 37. Explosives-screening samples were collected from sampling locations in the SWMU 25 open detonation crater area to ensure that the samples would not pose an explosive hazard during collection, shipping, or analysis. Samples collected for agent or explosives screening were not composited.

Sample splits for agent analysis were collected at the same time as samples for chemical analysis, geotechnical analysis, and field logging. The various sample splits remained in the custody of Army Technical Escort Unit (TEU) personnel or the CAMDS laboratory until chemical analysis confirmed that the samples were free of chemical agent. **Agent contamination was not detected in any of the samples.**

Because the open detonation area of SWMU 25 had the potential of containing relatively large concentrations of secondary explosives, samples were collected for preliminary explosives analysis. Special field techniques were used to collect the screening samples, because soil containing secondary explosives at greater than 10 percent by weight may have reacted explosively to heat, shock, or friction created by routine field sampling procedures and equipment. In collecting samples for preliminary explosives analysis, each planned sampling location was marked with a pin flag wetted with TEAD supply well water approved by USAEC for use in drilling and decontamination. A surface sample was collected at each pin flag using a nonsparking tool and placed in a plastic Ziploc bag. The pin flag and sample were labeled with the site identification information, and the sample was delivered to the UXO subcontractor personnel for total explosives screening analysis. This analysis revealed that the explosives concentration of all the samples was less than 10 percent by weight (Appendix I).

3.5 SOIL GAS SAMPLING

3.5.1 <u>Soil Gas Sampling Program</u>

Soil gas sampling was performed to identify the presence of VOCs and to determine the potential source area of any compounds identified. A total of 67 soil gas samples at SWMU 25 and 7 at SWMU 1 were collected from the survey locations shown on Figure 3.5-1 and analyzed for VOCs. Standards, duplicates, no-injection blanks, ambient air blanks, and probe blanks were

Figure 3.5-1

Soil Gas Sampling Locations and RFI-Phase II Monitoring Well Placement

analyzed throughout the field program to ensure quality control of the results. The soil gas locations and results were used to help establish RFI-Phase II monitoring well placement as shown in Figure 3.5-1.

Each sample location was screened for UXO prior to sampling. Initially, a 5/8-inch diameter steel probe was advanced 3 ft into the ground and then withdrawn. A sampling probe with a diameter slightly larger than 5/8-inch was then inserted 2 ft into this hole. At least four probe volumes were then purged from the sampling probe using a hand-operated vacuum pump. Once the probe volumes were purged, 1.0 milliliter (ml) sample of soil gas was collected through a septum located between the sampling probe and the vacuum pump with a Hamilton 1.0 ml gas-tight syringe. The sample was then injected into a Photovac 10S70 portable gas chromatograph (GC) for analysis.

The GC was calibrated to quantify trichloroethylene (TCE), tetrachloroethylene (PCE), benzene, toluene, and xylene with standards prepared from commercially available, spectroscopic-grade reagents. To prepare the standards, calculated volumes of these compounds were added to 250-ml amber glass bottles purged with hydrocarbon free air. This vapor standard was diluted into a second 250-ml amber glass bottle to make the working standard that was used to calibrate the GC. Calibration consisted of injecting the standard and setting the Photovac 10570 computer to recognize and quantify the chromatographic peak of each compound. All concentrations were reported in microliters of analyte per liter of air (parts per billion, or ppb). Calibration standards were analyzed every 6 to 8 samples as an instrument check.

In addition to quantifying target compounds, a qualitative determination was made for any unknown peaks recorded on the chromatograms, including any petroleum hydrocarbons that the Photovac was capable of detecting. These nontarget compounds are discussed briefly in the contamination assessment that follows.

3.5.2 Quality Assurance/Quality Control

No-injection blanks, ambient air blanks, and probe blanks were analyzed throughout the field program as a quality assurance/quality control (QA/QC) check to ensure that there was no carry-over (cross-contamination) between samples. Although carry-over associated within the GC is uncommon, no-injection blanks were analyzed to ensure that this did not occur. The no-injection blank process involves running an analysis without injecting anything into the GC. Ambient air blanks were analyzed to check for carry-over in the sampling syringe and consisted of injecting ambient air into the GC. Probe blanks were analyzed by pumping ambient air through the probe,

3.6 SOIL AND SOLID WASTE SAMPLING

Before releasing the revised final version of the Data Collection Quality Assurance Plan (EBASCO 1993b), the munitions disposal pit inventory was completed and the observations were presented to the Utah Department of Environmental Quality, Division of Solid and Hazardous Waste in October 1992. At that time, sampling locations were chosen to provide coverage of all of the types of disposal features identified in the inventory. Table 3.6-1 lists the samples and analyses that were planned during this meeting. The sampling included surficial and subsurface soils along with solid waste.

Because Army policies and procedures are still being developed for subsurface soil sampling in areas of potential agent presence, the field program limited subsurface soil sampling to those areas expected to be free of agent contamination. These areas included monitoring well drilling locations outside of the SWMU boundaries, portions of SWMUs 1 and 25 where no burial pits or trenches occur, and all of SWMU 37.

3.6.1 Soil Sampling Locations

During evaluation of data collected in the munitions disposal pit inventory and explosive risk determination, disposal features in SWMUs 1 and 25 were categorized, and surface or subsurface soil samples planned to characterize each type of feature (Table 3.6-1). Although most of the soil samples were located to characterize disposal pits or other features that are typically barren, some samples were collected in adjacent or nearby undisturbed areas where vegetation may take up dispersed contamination. Both types of samples were needed to characterize different exposure pathways in the risk assessment.

Any evidence of contamination observed in the field was used as a basis to select sampling locations. Preference was given to stained or disturbed areas and areas under or adjacent to waste debris. In several areas, additional criteria were used in selecting sampling locations. In the open detonation crater area of SWMU 25, four sampling locations were selected in a line approximately perpendicular to the east-west trend of the detonation craters. Two of the locations were selected between rows of craters and two were inside the SWMU but to the north and south of the cratered area. Other soil samples were collected below the metallic debris in the windrows. Ash-mound area samples were collected from below the ash. Incendiary burn area samples were collected from the center of burn areas that remain barren from more recent or frequent use. Four subsurface soil samples were collected from the borehole completed as well

Table 3.6-1 Soil Sampling During the RFI - Phase II at SWMUs 1, 25, and 37, Page 1 of 4

SWMU	Features	Site ID (No. Samples)	Site Type (Depth)	Volatile Organics	BNAs	PCBs	Explosives	Metals (ICP , As, Se, Pb, Hg)	Cyanide	IMPA, MPA, EMPA, FC2A	Thiodiglycol	RCRA Characteristics (Toxicity, Ignitability, Corrosivity, Reactivity)
1	Mustard Holding Area (MHA)	01-MHA1	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MHA2	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Mustard Holding Area Undist. (MHAU)	01-MHAU	Grab (Surficial soil)		•	•	•	•	•	•	•	
	Hummocky Burial Area (HBA)	01-HBA-84	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-HBA-85	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-HBA-92	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-HBA-93	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-HBA-93A	Dupe	•	•	•	•	•	•	•	•	
	4.2" Mortar Pits (MP)	01-MP-82	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MP-89	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MP-89A	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MP-89B	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MP-89C	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	4.2" Mortar Pit Vicinity Undist. (MPVU)	01-MPVU1	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-MPVU2	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-MPVU3	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-MPVU4	Comp (Surficial soil)		•	•	•	•	•	•	•	
	Mustard Storage Drums (MSD)	01-MSD-58	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-MSD-59	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Covered Pits (CP)	01-CP-44	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-CP-63A	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-CP-89B	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Training Area (TA)	01-TA-301	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-TA-302	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Decontamination Area (DA)	01-DA-441	STB only									•
		01-DA-442	Grab (Surficial soil)	•	•	•	•	•	•	•	•	

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Table 3.6-1 Soil Sampling During the RFI - Phase II at SWMUs 1, 25, and 37, Page 2 of 4

SWMU	Features	Site ID (No. Samples)	Site Type (Depth)	Volatile Organics	BNAs	PCBs	Explosives	Metals (ICP , As, Se, Sb, Hg)	Cyanide	IMPA, MPA, EMPA, FC2A	Thiodiglycol	RCRA Characteristics (Toxicity, Ignitability, Corrosivity, Reactivity)
1 *(cont)*	Incendiary Ash Mounds (IAM)	01-IAM-08	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-IAM-08A	Dupe	•	•	•	•	•	•	•	•	
		01-IAM-11	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-IAM-13	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-IAM-15	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Napalm Bomb Area (NBA)	01-NBA-61	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Incendijel Area (IA)	01-IA-60	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-IA-80	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-IA-88	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Crate Burn Area (CBA)	01-CBA-8	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-CBA-30	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	155mm Propellant Charge Cannister Area (PCA)	01-PCA-74	Grab (Surficial soil)		•	•	•	•	•	•	•	
		01-PCA-88	Grab (Surficial soil)		•	•	•	•	•	•	•	
	Propellant Burn Area (PBA)	01-PBA-55	Comp (Surficial soil)		•	•	•	•	•	•	•	
	Smoke Pot Disposal Area (SPDA)	01-SPDA-77	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		01-SPDA-99	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Incendiary Burn Area Vicinity (IBA)	01-IBA1	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-IBA2	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-IBA3	Comp (Surficial soil)		•	•	•	•	•	•	•	
		01-IBA4	Comp (Surficial soil)		•	•	•	•	•	•	•	
	Southeast Corner of SWMU 1 (SEC1)	01-SEC1	Comp (Surficial soil)		•	•	•	•	•	•	•	
	Northeast Air Station (NEAS)	01-NEAS1	Comp (Surficial soil)		•	•	•	•	•	•	•	

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Table 3.6-1 Soil Sampling During the RFI - Phase II at SWMUs 1, 25, and 37, Page 3 of 4

SWMU	Features	Site ID (No. Samples)	Site Type (Depth)	Volatile Organics	BNAs	PCBs	Explosives	Metals (ICP, As, Se, Sb, Hg)	Cyanide	IMPA, MPA, EMPA, FC2A	Thiodiglycol	RCRA Characteristics (Toxicity, Ignitability, Corrosivity, Reactivity)
				Analytical Parameters								
25	Open Detonation Crater (ODC)	25-ODC-92	Comp (Surficial soil)		•	•	•	•	•	•	•	
		25-ODC-119	Comp (Surficial soil)		•	•	•	•	•	•	•	
		25-ODC-108	Comp (Surficial soil)		•	•	•	•	•	•	•	
			Grab (4 - 5 ft.)		•	•	•	•	•	•	•	
			Grab (9 - 10 ft.)		•	•	•	•	•	•	•	
		25-ODC-110	Comp (Surficial soil)		•	•	•	•	•	•	•	
			Grab (4 - 5 ft.)		•	•	•	•	•	•	•	
			Grab (9 - 10 ft.)		•	•	•	•	•	•	•	
	Isolated Detonation Crater (IDC)	25-IDC-10	Grab (Surficial soil)		•	•	•	•	•	•	•	
		25-IDC-10A	Dupe		•	•	•	•	•	•	•	
	Windrows (WIND)	25-WIND	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
			Grab (4 - 5 ft.)	•	•	•	•	•	•	•	•	
			Grab (9 - 10 ft.)	•	•	•	•	•	•	•	•	
	Ash Mounds (AM)	25-AM-58	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
			Grab (4 - 5 ft.)	•	•	•	•	•	•	•	•	
			Grab (9 - 10 ft.)	•	•	•	•	•	•	•	•	
		25-AM-58	Dupe (4 - 5 ft.)	•	•	•	•	•	•	•	•	
	Incendiary Burn Area (IBA)	25-IBA-59	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
			Bore (4 - 5 ft.)	•	•	•	•	•	•	•	•	
			Bore (9 - 10 ft.)	•	•	•	•	•	•	•	•	
		25-IBA-65	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
			Bore (4 - 5 ft.)	•	•	•	•	•	•	•	•	
		25-IBA-67	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		25-IBA-60	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		(Well S-100-92)	Bore (4 - 6 ft.)	•	•	•	•	•	•	•	•	
			Bore (9 - 11 ft.)	•	•	•	•	•	•	•	•	
	Covered Trenches (CT)	25-CT-07	Grab (Surficial soil)		•	•	•	•	•	•	•	
		25-CT-08	Grab (Surficial soil)		•	•	•	•	•	•	•	
		25-CT-52	Grab (Surficial soil)		•	•	•	•	•	•	•	
	4.2" Mortar Area (MA)	25-MA1	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
		25-MA2	Grab (Surficial soil)	•	•	•	•	•	•	•	•	

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Table 3.6-1 Soil Sampling During the RFI - Phase II at SWMUs 1, 25, and 37, Page 4 of 4

SWMU	Features	Site ID (No. Samples)	Site Type (Depth)	Volatile Organics	BNAs	PCBs	Explosives	Metals (ICP , AS, Se, Sb, Hg)	Cyanide	IMPA, MPA, EMPA, FC2A	Thiodiglycol	RCRA Characteristics (Toxicity, Ignitability, Corrosivity, Reactivity)
25 (cont)	Napalm Incineration Area (NIA)	25-NIA-52	Grab (Surficial soil)	•	•	•	•	•	•	•	•	
	Undisturbed Areas (UA)	25-UA1	Comp (Surficial soil)		•	•	•	•	•	•	•	
		25-UA2	Comp (Surficial soil)		•	•	•	•	•	•	•	
		25-UA3	Comp (Surficial soil)		•	•	•	•	•	•	•	
	Northwest Air Statlon (NWAS)	25-NWAS	Comp (Surficial soil)		•	•	•	•	•	•	•	
37	Slag Piles (SP)	37-SP1	Bore (Surficial soil)	•	•		•	•	•	•	•	
			Bore (1/2 - 1 ft.)	•	•		•	•	•	•	•	
			Bore (2 - 3 ft.)	•	•		•	•	•	•	•	
		37-SP2	Grab (Surface waste)									•
			Bore (Surficial soil)	•	•		•	•	•	•	•	
			Bore (1/2 - 1 ft.)	•	•		•	•	•	•	•	
			Bore (2 - 3 ft.)	•	•		•	•	•	•	•	
		37-SP3	Bore (Surficial soil)	•	•		•	•	•	•	•	
			Bore (1/2 - 1 ft.)	•	•		•	•	•	•	•	
			Bore (2 - 3 ft.)	•	•		•	•	•	•	•	
	Bomb Fragments (BF)	37-BF1	Grab (Surficial soil)	•	•		•	•	•	•	•	
			Grab (1/2 - 1 ft.)	•	•		•	•	•	•	•	
			Grab (2 - 3 ft.)	•	•		•	•	•	•	•	
		37-BF2	Grab (Surficial soil)	•	•		•	•	•	•	•	
			Grab (1/2 - 1 ft.)	•	•		•	•	•	•	•	
			Grab (2 - 3 ft.)	•	•		•	•	•	•	•	

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S-93-92. These samples were collected in place of groundwater samples from a moist zone near the planned completion depth. Groundwater samples could not be collected at this depth in this well since the zone was insufficiently saturated. The borehole was then deepened and completed in an underlying confined aquifer.

3.6.2 Soil Sample Collection

All surficial soil samples were collected using a stainless steel scoop and bowl. Two sampling methods were used to collect surface samples. In undisturbed areas, incendiary burn areas, and at the surface of covered disposal pits, surface soil samples were collected to characterize areas where contamination may have been dispersed during waste disposal or by wind or surface-water transport. Each undisturbed area sample was a composite of six samples collected about a central sampling location point. In uncovered disposal pits and at other features where the likely locations of contaminant releases were indicated by metallic wastes or other debris left by the disposal process, a soil sample was collected as close as possible to the remaining waste or debris. The sample was then geologically logged and containerized for sample shipment or archival purposes. The geologic data was subsequently coded and entered into the Installation Restoration Data Management Information System (IRDMIS). The surficial and shallow boring logs are presented in Appendix A1. Solid waste samples were also collected with a stainless steel scoop from a slag pile in SWMU 37 and from materials contained in a super tropical bleach (STB) container from SWMU 1.

The subsurface soil samples collected at SWMUs 25 and 37 were collected either with a drill rig where no UXO were located or with a backhoe where surface debris prevented downhole UXO detection. Table 3.6-2 lists the method of collection for the subsurface samples at SWMUs 25 and 37. The majority of soil samples obtained during monitoring well drilling were obtained with the use of a split-spoon sampler. When air rotary drilling was used, often a chip-type sample was collected into a strainer from the discharge cyclone.

Table 3.6-3 lists the preservation methods and soil sample container requirements.

3.6.3 Soil Sample Chemical Analyses

Because waste disposal occurred in SWMUs 1 and 25 more than 20 years ago, VOCs related to waste disposal were not expected to be present in any surface soil samples. However, for confirmation purposes, VOC analysis was performed on approximately 66 percent of the samples in SWMUs 1 and 25. Each soil sample was analyzed for SVOCs, explosives, agent breakdown products, metals, and cyanide. For samples from SWMU 37, the analytical suite included VOCs, SVOCs (base-neutral/acid extractable semivolatile organics [BNAs] only), explosives, agent breakdown products, metals, and cyanide. Although each of the analytes may not have been

Table 3.6-2 Subsurface Soil Collection Methods At SWMUs 25 and 37

Location	Depth (ft)	Subsurface Collection Method
25-AM-58	10	Backhoe
25-IBA-59	10	Drill Rig
25-IBA-60 (Well S-100-92)	11	Drill Rig
25-IBA-65	5	Drill Rig
25-ODC-108	10	Backhoe
25-ODC-110	10	Backhoe
25-WIND	10	Backhoe
37-BF1	3	Backhoe
37-BF2	3	Backhoe
37-SP1	3	Drill Rig
37-SP2	3	Drill Rig
37-SP3	3	Drill Rig

Table 3.6-3 • Preservation Methods and Soil Sample Container Requirements, Page 1 of 1

Soil Analysis	Container	Preservation
Volatile Organics	2 x 40 ml glass[1]	Cool to 4° C
Semivolatile Organic Compounds Base-Neutral/Acid (Gas chromatography/Mass spectrophotometer) PCBs (Gas chromatography) **Explosives** **Metals** ICP Metals, As, Se, Pb, Hg Cyanide	2 x 500 ml glass	Cool to 4° C
Agent Breakdown Products IMPA, MPA, EMPA Fluoroacetic Acid Thiodiglycol	2 x 500 ml glass	Cool to 4° C
RCRA Characteristics Toxicity Ignitability Corrosivity Reactivity	2 x 500 ml glass	Cool to 4° C
pH **Total Organic Carbon** **Conductivity**	1 x 500 ml glass	

[1] All glass containers will be amber in color.

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ml - milliliter

°C - degrees Celsius

Please see Chemical Acronym List for acronym definitions

released in all parts of these SWMUs, these analyses were conducted to assess contaminant dispersion from primary release points. In addition, four soil samples were taken from well S-93-92 (initially identified as Testhole) at the following depth intervals: 74 to 76, 104 to 106, 119 to 121, and 129 to 131 ft. These samples underwent analysis for VOCs, SVOCs (BNAs only), explosives, agent breakdown products, metals, and cyanide. RCRA characteristic analyses (specifically toxicity, ignitability, corrosivity, and reactivity) for waste samples from SWMUs 1 and 37 were inadvertently omitted by the analytical laboratory. These analyses should be conducted from additional samples collected during any future removal actions to provide current data to use in characterizing and arranging proper disposal of the wastes at that time.

Chemical analyses were performed using EPA SW-846 methods and USAEC-approved methods, most of which were developed from SW-846 methodologies. Methods developed solely by USAEC were used for analyses of compounds for which no SW-846 method exists. The analytical program for soil and groundwater samples included gas chromatography/mass spectrometry (GC/MS) VOCs, GC/MS BNAs, polychlorinated biphenyls (PCBs), explosives, metals (dissolved metals in groundwater only), and cyanide. Both EPA and USAEC QC programs were followed, ensuring thorough scrutiny of the data quality.

3.6.4 Soil Sample Geotechnical Analyses

A contracted laboratory conducted geotechnical analyses on 40 samples. These analyses included grain size, plasticity, classification using the Unified Soil Classification System (USCS), moisture content, soil pH, and total organic carbon content. Geotechnical samples were obtained from a wide range of SWMU 1 and 25 locations to support the risk assessment at these SWMUs. No geotechnical samples were collected at SWMU 37 because they were not needed to satisfy the objective of determining the presence or absence of contamination at this SWMU. The samples selected from shallow-type borings were chosen to adequately cover the areas sampled and the soil types encountered. The geotechnical samples submitted from the nine new monitoring well locations typically represent the soil types near the water-bearing zone. The complete results of the geotechnical parameters are found in Appendix A3.

3.7 MONITORING WELL INSTALLATION AND DEVELOPMENT

A total of nine groundwater monitoring wells (S-93-92 and S-95-92 through S-102-92) were installed at SWMUs 1 and 25 for RFI-Phase II (Figure 3.5-1) to further characterize the distribution of the relatively low concentrations of groundwater contaminants that were detected sporadically at these SWMUs in the RFI-Phase I and previous investigations. These wells

soil sample was analyzed for SVOCs, explosives, agent breakdown products, metals, and cyanide. For samples from SWMU 37, the analytical suite included VOCs, SVOCs (base-neutral/acid extractable semivolatile organics [BNAs] only), explosives, agent breakdown products, metals, and cyanide. Although each of the analytes may not have been released in all parts of these SWMUs, these analyses were conducted to assess contaminant dispersion from primary release points. In addition, four soil samples were taken from well S-93-92 (initially identified as Testhole) at the following depth intervals: 74 to 76, 104 to 106, 119 to 121, and 129 to 131 ft. These samples underwent analysis for VOCs, SVOCs (BNAs only), explosives, agent breakdown products, metals, and cyanide. RCRA characteristic analyses for waste samples from SWMUs 1 and 37 were inadvertently omitted by the analytical laboratory.

Chemical analyses were performed using EPA SW-846 methods and USAEC-approved methods, most of which were developed from SW-846 methodologies. Methods developed solely by USAEC were used for analyses of compounds for which no SW-846 method exists. The analytical program for soil and groundwater samples included gas chromatography/mass spectrometry (GC/MS) VOCs, GC/MS BNAs, polychlorinated biphenyls (PCBs), explosives, metals (dissolved metals in groundwater only), and cyanide. Both EPA and USAEC QC programs were followed, ensuring thorough scrutiny of the data quality.

3.6.4 Soil Sample Geotechnical Analyses

A contracted laboratory conducted geotechnical analyses on 40 samples. These analyses included grain size, plasticity, classification using the Unified Soil Classification System (USCS), moisture content, soil pH, and total organic carbon content. Geotechnical samples were obtained from a wide range of SWMU 1 and 25 locations to support the risk assessment at these SWMUs. No geotechnical samples were collected at SWMU 37 because they were not needed to satisfy the objective of determining the presence or absence of contamination at this SWMU. The samples selected from shallow-type borings were chosen to adequately cover the areas sampled and the soil types encountered. The geotechnical samples submitted from the nine new monitoring well locations typically represent the soil types near the water-bearing zone. The complete results of the geotechnical parameters are found in Appendix A3.

3.7 MONITORING WELL INSTALLATION AND DEVELOPMENT

A total of nine groundwater monitoring wells (S-93-92 and S-95-92 through S-102-92) were installed at SWMUs 1 and 25 for RFI-Phase II (Figure 3.5-1) to further characterize the distribution of the relatively low concentrations of groundwater contaminants that were detected

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monitor the uppermost water-bearing zone capable of yielding a significant amount of water to wells or springs.

Two wells were planned at the southeastern corner of SWMU 1 due to the reinterpretation of the groundwater flow direction in the RFI-Phase I report. During the RFI-Phase I and previous field investigations, groundwater was expected to flow south or south-southeast through SWMU 1. However, RFI-Phase I data suggested that groundwater may enter SWMU 1 from the south, west, and north and exit at the southeast corner. Since this area is indicated as a potentially important transport pathway for contaminant release across most of the SWMU, a two-well vertical cluster was proposed. However, since drilling the upper water-bearing zone yielded only trace amounts of water, a shallow well was not installed in this area. Four soil samples were collected from the moist zone to evaluate whether contamination occurred there. Then drilling was continued to a deeper water-bearing zone from which sufficient quantities of water could be produced and a deep well (S-93-92) installed.

Three wells (S-99-92, S-101-92 and S-102-92) were installed downgradient from well S-66-90 in SWMU 25. RFI-Phase I samples from this well indicated that fuels or solvents had been released to groundwater in this area, possibly through the use of these chemicals in munitions burning at the windrows. The locations of the three new wells were selected using the results of the soil gas sampling program.

Two wells (S-98-92 and S-100-92) were installed near the windrows and ash mounds in SWMU 25. Well S-98-92 was installed upgradient from the windrows to provide data on local background conditions. Well S-100-92 was installed downgradient from the ash mounds. This well was installed and sampled to determine whether contaminants have been released to groundwater through emplacement or burning of the wastes in these ash mounds.

Well S-95-92 was installed south of the eastern part of SWMU 25 and well S-97-92 installed between SWMUs 1 and 25 to assess whether contaminants are migrating from SWMU 25 into off-site areas or SWMU 1. These wells provide chemical analytical information as well as water-level data needed to improve the resolution of groundwater flow directions in these SWMUs.

One well (S-96-92) was installed inside SWMU 1 between disposal features in an area used for agent munitions disposal. This area contains both open and closed pits. This well was installed

to provide an indication of whether releases have occurred from the numerous disposal pits in this area or from the northwestern part of this SWMU.

Wells were drilled and installed following the field operating procedures (FOPs) outlined in the guidelines provided in the USATHAMA Geotechnical Requirements (1987). Procedures were modified, however, to include the use of air rotary drilling as explained below.

The drilling subcontractor ensured that all State of Utah drilling requirements were met. EBASCO obtained permits for drilling each well and, with the drillers, submitted all required well completion forms to the state.

3.7.1 Drilling Methods

As shown in Table 3.7-1, most boreholes were initiated using hollow-stem augers (HSA). However, drill crews had access to air rotary rigs to allow drilling through gravels or to drill wells beyond the expected total depth when the first water-bearing zone could not be reached by augering. Occasionally, water from the USAEC-approved on-post supply was added to the airstream to improve recovery of cuttings downhole. The amount of this water used and the amount lost to the formation was monitored and recorded to allow for recovery during well development.

3.7.2 Borehole Sampling

Before well S-93-92 was installed at the southeastern corner of SWMU 1, a stratigraphic test borehole was drilled and logged. This test hole was sampled using 2-ft long split spoons at 5-ft intervals (or less) to define the subsurface lithologies and locate water-bearing zones. Based on results of the test hole, only one well was installed at this location.

In other boreholes, subsurface stratigraphy generally was characterized by collecting 2-ft long split spoons at 5-ft intervals. The cores were opened and logged by the Field Geologist under the supervision of the Health and Safety Officer. Afterwards, these samples were described in the field logs and placed in glass jars for archiving. Air rotary chip samples obtained from the drill rig cyclone were also logged and placed in glass jars for archiving. Twenty of these archived samples were subsequently submitted for geotechnical analysis (Appendix A3).

Table 3.7-1 Well Construction Summary for RFI-Phase II-TEAD-S

Well ID	SWMU Number	Boring Depth*	Drilling Method	Sampling Method	Well Depth*	Screen Length* (depth interval)	Filter Pack* (depth interval)	Seal Thickness* (depth interval)	Top Of PVC Casing Elevation*	Ground Elevation*	UTM Coordinants 1927 N.A.D. (Meters)	
											North	East
S-93-92	1	150.0	HSA/AIR	SS	151.5	15.5	23.5	9.0	5072.95	5070.14	4,457,491.015	338,015.628
						(136.0 - 151.5)	(128.0 - 151.5)	(119.0 - 128.0)				
S-95-92	25	131.0	HSA/AIR	SS/CHIPS	128.0	25.5	31.0	13.0	5046.06	5043.98	4,457,494.053	385,734.201
						(102.5 - 128.0)	(97.0 - 128.0)	(84.0 - 97.0)				
S-96-92	1	114.9	HSA	SS	114.5	15.0	20.0	11.5	5071.51	5069.25	4,457,916.408	387,623.575
						(99.5 - 114.5)	(94.5 - 114.5)	(83.0 - 94.5)				
S-97-92	25	83.5	HSA/AIR	SS/CHIPS	83.0	10.5	18.0	6.0	5086.54	5083.96	4,457,850.194	386,431.553
						(72.5 - 83.0)	(65.0 - 83.0)	(59.0 - 65.0)				
S-98-92	25	41.0	HSA/AIR	SS/CHIPS	39.2	10.5	15.9	6.1	5048.76	5046.31	4,459,151.277	385,240.836
						(28.7 - 39.2)	(23.3 - 39.2)	(17.2 - 23.3)				
S-99-92	25	40.0	HSA/AIR	SS/CHIPS	38.5	10.5	15.5	6.5	5048.94	5046.54	4,458,206.544	385,934.661
						(28.0 - 38.5)	(23.0 - 38.5)	(16.5 - 23.0)				
S-100-92	25	74.7	HSA	SS	74.3	15.0	20.3	5.0	5076.88	5074.67	4,458,927.809	386,179.374
						(59.3 - 74.3)	(54.0 - 74.3)	(49.0 - 54.0)				
S-101-92	25	52.0	AIR	SS/CHIPS	50.5	10.5	16.5	5.0	5059.32	5056.81	4,458,479.391	385,791.981
						(40.0 - 50.5)	(34.0 - 50.5)	(29.0 - 34.0)				
S-102-92	25	44.0	HSA	SS	44.0	10.5	16.0	5.0	5053.76	5051.54	4,458,464.262	385,910.937
						(33.5 - 44.0)	(28.0 - 44.0)	(23.0 - 28.0)				

* All values in feet unless specified
HSA Hollow-Stem Auger Drilling
AIR Air Rotary Drilling
SS Split-Spoon Sampling
CHIPS Chip Samples from Air Rotary method

3.7.3 Well Construction

The Field Geologist based well construction designs on subsurface lithology determined from cores, cuttings, and drilling conditions. In air rotary drilling, this information was supplemented by any cutting descriptions that had been logged by the Field Geologist. All well construction design conformed with the USATHAMA Geotechnical Requirements (1987).

Borehole total depths and water levels were measured and recorded prior to well installation. Water levels were measured until static conditions had been achieved and sufficient water was produced so that each well would be representative of the local groundwater conditions.

Well construction began, to the extent practicable, within 48 hours of boring completion, and was supervised by the Field Geologist to ensure compliance with USATHAMA Geotechnical Requirements (1987). Four-inch inside diameter (ID) schedule 40 polyvinyl chloride (PVC) well casing and screens were installed once they had been properly decontaminated. The screened intervals in the monitoring wells are generally 10 to 15 ft, unless a larger interval was indicated by the hydrogeology. Table 3.7-1 summarizes the well construction information including total depth, drilling method, screened interval, and other construction specifications. A generalized well construction and surface completion is illustrated in Figure 3.7-1. Further details on each of the nine new monitoring wells can be found in Appendix A1 on the appropriate Well Construction Log. This data was subsequently coded and entered into the IRDMIS database.

For groundwater sampling, a dedicated bailer was left suspended inside each well. However, the sampling rope was replaced after each sampling event to ensure that a clean rope would be used for each future sampling event. These bailers were thoroughly decontaminated by a contractor laboratory and approved by USATHAMA prior to installation. Using dedicated bailers reduces the potential for cross-contamination between wells during sampling events.

3.7.4 Well Development

Each well was developed to increase the hydraulic connection between the well and the surrounding aquifer. Generally, each monitoring well was developed no sooner than 48 hours and no later than 7 consecutive days after well construction. There were two exceptions to this: wells S-95-92 and S-96-92. Development at both wells was delayed due to the Thanksgiving holiday break in field operations. Well S-95-92 also required additional development time beyond the normal range (1 to 4 days) due to the extra water that was introduced during drilling operations, and to overall slow recovery.

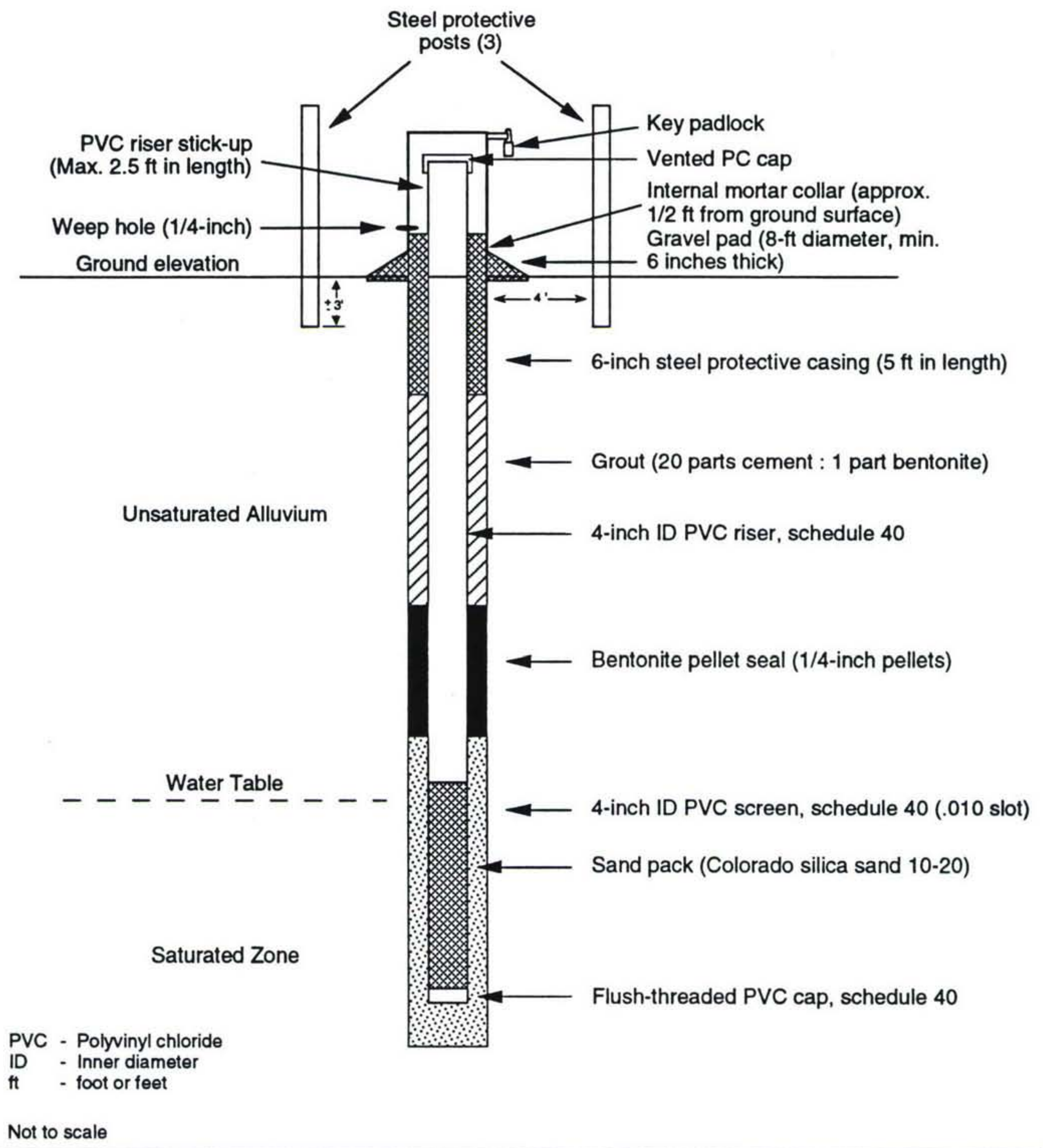

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Figure 3.7-1

Generalized Well Construction and Surface Completion

Tooele Army Depot - South Area
Prepared by : Ebasco Services Incorporated

EBASCO

The Field Geologist calculated the volume of water to be removed during well development. This included removal of five times the total amount of lost drilling fluid, plus water used in filter pack emplacement, plus water standing in the casing and annulus. The amount of water in the saturated annulus was calculated based on an assumed 30 percent porosity. The development water was removed using a decontaminated bailer. The Field Geologist recorded pH, specific conductivity, dissolved oxygen, and temperature readings for every volume of water bailed from the well. Development was complete when the appropriate volume of water had been removed from the well and the parameters had stabilized. The parameters were considered stable when three consecutive readings of pH, temperature, and conductivity did not deviate by more than 20 percent. All water removed was contained in 55-gallon drums for later disposal as either hazardous or nonhazardous wastes, depending on analytical results for groundwater samples from that well. Well development records are included in Appendix A1.

Prior to and following each well development, the Field Geologist calibrated both the pH and the conductivity meters per manufacturer's instructions. A copy of these instructions was kept with each instrument.

3.8 GROUNDWATER SAMPLING

Groundwater samples were obtained from wells for the full suite of analyses described in Table 3.8-1. These wells included each well installed under this program, all existing monitoring wells at SWMUs 1 and 25, and the USAEC-approved water supply well.

The Field Geologist was responsible for collecting groundwater samples in each well installed under this program no sooner than 14 days after well development was completed. This time allowed for well stabilization. The headspace in the monitoring wells was monitored for VOCs immediately after the well was uncapped. No headspace concentrations above background were measured. All samples were collected after five times the volume of water in the polyvinyl chloride (PVC) casing and saturated well annulus had been removed using a pump or dedicated PVC bailer. When a pump was used, the first four volumes were pumped and the last volume was bailed using the dedicated PVC bailer. All water removed from the borehole was drummed for later disposal as hazardous or nonhazardous waste, according to the results of groundwater analyses. The Field Geologist recorded pH, specific conductivity, dissolved oxygen, and temperature readings after each casing volume was removed. If the well dewatered during purging, it was allowed to recharge before being sampled. The field documentation of pre-sample purging is presented in Appendix A2.

Table 3.8-1 Groundwater Sampling During the RFI-Phase II at SWMUs 1, 25, and 37, Page 1 of 1

SWMU	Feature	Site ID	Volatile Organics	BNAs	PCBs	IMPA, MPA, EMPA, FC2A	Thiodiglycol	Explosives	Dissolved Metals (ICP, As, Se, Pb, Hg)	Anions (Cl, Br, Fl, Bicarbonate, Sulfate)	Anions (NO_2, NO_3)	Cyanide	Sample Depth (ft)
1	Munitions Disposal Pits	S-4	•	•	•	•	•	•	•	•	•	•	83
		S-5	•	•	•	•	•	•	•	•	•	•	48
		S-69-90	•	•	•	•	•	•	•	•	•	•	112
		S-70-90	•	•	•	•	•	•	•	•	•	•	50
		S-71-90	•	•	•	•	•	•	•	•	•	•	66
		S-93-92	•	•	•	•	•	•	•	•	•	•	150
		S-96-92	•	•	•	•	•	•	•	•	•	•	114
25	Munitions Disposal Pits	S-68-90	•	•	•	•	•	•	•	•	•	•	60
		S-95-92	•	•	•	•	•	•	•	•	•	•	128.4
		S-97-92	•	•	•	•	•	•	•	•	•	•	80
	Ash Mounds	S-100-92	•	•	•	•	•	•	•	•	•	•	75
	Windrows	S-66-90	•	•	•	•	•	•	•	•	•	•	94.5
		S-98-92	•	•	•	•	•	•	•	•	•	•	41
		S-99-92	•	•	•	•	•	•	•	•	•	•	38
		S-101-92	•	•	•	•	•	•	•	•	•	•	50
		S-102-92	•	•	•	•	•	•	•	•	•	•	41
	Other	S-6	•	•	•	•	•	•	•	•	•	•	25
		S-7	•	•	•	•	•	•	•	•	•	•	44
		S-18-88	•	•	•	•	•	•	•	•	•	•	37
		S-19-88	•	•	•	•	•	•	•	•	•	•	37
		S-64-90	•	•	•	•	•	•	•	•	•	•	34
		S-65-90	•	•	•	•	•	•	•	•	•	•	28
		S-67-90	•	•	•	•	•	•	•	•	•	•	27
37	No planned sampling at SWMU 37												

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The Field Geologist was responsible for the preparation and maintenance of equipment required for groundwater sampling as outlined in detail in the FOPs in Appendix A of the RFI-Phase II Data Collection Quality Assurance Plan (EBASCO, 1993b). Prior to and following each well sampling, the Field Geologist calibrated both the pH and the conductivity meters per the manufacturer's instructions. A copy of these instructions was kept with each instrument.

Samples were collected in appropriate containers (Table 3.8-2). All glass vials were amber in color. All sample containers were cleaned, rinsed, packaged, and labeled at the laboratory and delivered to the site with correct preservatives in separate containers. In the field, the bottles were prepared with the preservatives listed in Table 3.8-2, after they were triple rinsed with the water being sampled. This rinsing procedure neutralizes chemical binding sites on the inside surface of the container. Before transportation, the samples were packed with ice to maintain the samples at 4°C.

Loss of VOCs to evaporation was minimized by transferring samples to the 40-ml vials rapidly but without agitation. VOC sample containers were filled to capacity so no air bubbles remained and shipped in metal cans filled with vermiculite. Because past experience at this site has shown that suspended solids in samples from fine-grained aquifer zones introduce an unacceptable variability in the sample results, only unfiltered samples were collected for metals analyses. These metals samples were pre-filtered using a 0.45-micron filter and then passed through a 0.10-micron filter to remove colloids.

3.8.1 Monitoring Well Surveying

A qualified subcontractor surveyed each monitoring well for horizontal and vertical control. The minimum requirements of the surveying were the following:

> The horizontal control for each well installed under this contract was surveyed to determine its state planar and military map coordinates to within 0.5 ft.
>
> The vertical control included determination of the elevation of the natural ground surface and the highest point on the rim of the uncapped well casing (not protective casing) of each well to within 0.01 ft using the National Geodetic Vertical Datum of 1927.

Corrected survey field data included loop closure for survey accuracy. These data list the coordinates, system, and elevations (see Appendix C). The names, characteristics, and locations

Table 3.8-2 • Preservation Methods and Water Sample Container Requirements

Water Analysis	Container	Preservation	
Volatile Organics	4 x 40 ml glass	None	Cool to 4° C
Semivolatile Organic Compounds			
Base-Neutral/Acid (GC/MS)	2 x 1 l glass	None	Cool to 4° C
PCBs (GC)	2 x 1 l glass	None	Cool to 4° C
Agent Breakdown Products			
IMPA, MPA, EMPA	2 x 250 ml septum cap vial	None	Cool to 4° C
Fluoroacetic Acid			
Thiodiglycol	3 x 1 l glass	None	Cool to 4° C
Explosives	Included with Thiodiglycol volume	None	Cool to 4° C
Dissolved Metals			
ICP Metals, As, Se, Pb, Hg	1 x 1 l plastic	HNO_3 to pH < 2	Cool to 4° C
Anions			
Cl, Br, Fl, Bicarbonate, Sulfate	1 x 1 l plastic cubitainer	None	Cool to 4° C
NO_2, NO_3	1 x 1 l plastic cubitainer	H_2SO_4 to pH <2	Cool to 4° C
Cyanide	1 x 1 l plastic cubitainer	NaOH to pH > 12	Cool to 4° C

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ml - milliliter
l - liter
°C - degrees Centigrade
GC/MS - Gas chromatography/mass spectrophotometer
GC - Gas chromatography

Please see Chemical Acronym List for acronym definitions

of all permanent and semipermanent reference marks used for horizontal and vertical control were noted.

3.8.2 Groundwater Elevation Measurements

Groundwater elevations were measured and recorded during well construction, well development, and at the time of sampling, as is specified in the FOPs. In addition, after all wells were installed, water levels were measured and recorded within a single 24-hour period from all wells at TEAD-S. Two rounds of water-level measurements were completed during the RFI-Phase II. One round was completed in February 1993 and the other in August 1993. These data are presented in Section 4.1.1.3, and were used to construct the water-elevation maps shown in Figures 4.1-15 and 4.1-16.

The Field Geologist measured the depth to groundwater in each well with an electronic water-level meter. The depth was measured from the highest point on the rim of the PVC well casing and was recorded to the nearest 0.01 ft in the field data logbook. The meter tape and other downhole materials were thoroughly rinsed with USAEC-approved water between uses. The depth to groundwater and casing stickup were recorded in the logbook with the well name, date, and time of measurement. All of these recorded data are stored in the IRDMIS database as is outlined in the Data Management Plan (EBASCO 1993b).

3.9 AQUIFER TESTING

Aquifer tests were performed to determine the hydraulic properties of the upper saturated zone at SWMUs 1 and 25. This information is used to estimate groundwater travel times. It also indicates whether an aquifer zone is productive enough to be used as a water supply.

After well development, sampling, and subsequent stabilization of the water level, single well hydraulic conductivity tests, known as slug tests, were performed in 20 monitoring wells at SWMUs 1 and 25. These tests are useful for evaluating relatively fine-grained, low-conductivity aquifers and for conducting tests in many wells during a short time period.

Slug tests allow estimation of local hydraulic conductivity by observing the aquifer response to a stress applied to a small zone around each well. Stress was applied by instantaneously reducing the head in a well by withdrawing a closed PVC cylinder. This technique resulted in an order of magnitude estimate of horizontal hydraulic conductivity in the immediate vicinity of the well.

3.9.1 Aquifer Test Procedure

During aquifer tests, a well was opened and the air in the upper part of the casing was monitored using organic vapor analyzers, the static water level was measured and verified to the nearest 0.01 ft using a decontaminated electronic water-level meter, and the total depth of the well was measured and verified using a decontaminated weighted tape. The water level and total depth measurements were recorded and compared to well installation, development, and sampling records to confirm that water levels had stabilized. After the water level had stabilized, the test equipment was set up.

A pressure transducer (sensitive within 0 to 30 pounds per square inch for deeper wells) was connected to an in situ Hermit SE 1000 data logger. The data logger was programmed to sample water levels within the well in a logarithmic time interval mode. All transducer specifications provided by the manufacturer, such as serial number, linearity, scale, and offset were programmed into the data logger. The transducer was referenced to the static water level as measured from the top of casing and lowered to its preplanned depth within the well (below the planned bottom of the slug for a slug injection test or below the bottom of the screen for a baildown test). The transducer was allowed to adjust to groundwater temperature before further measurements were made.

Because the transducer and the transducer line displace water within a well, the water-level meter was used to measure the new water level after the transducer was placed in the well. The transducer reading was then checked against the water-level meter reading and the reference level on the data logger set to the new water level. The transducer line was secured to the well casing and marked with electrical tape so that the referenced depth could be maintained. A calibration test was then performed. When the data logger and the transducer were functioning correctly, the well test was initiated.

For the slug injection test, one to three 5-ft-long by 3-inch-diameter sections of flush threaded PVC slug were attached to a decontaminated nylon rope. Strips of electrical tape were attached to the rope at reference locations to ensure that the slug would hang just above the water level before the start of the test and approximately 2 ft below the starting water level as the test began. The slug was secured above the water level while the data logger was set up by entering the appropriate programmed variables. Just before the test began, the water level was verified and the transducer referenced to a new water level. When all of the equipment was in place and the data logger and transducer were operating correctly, the logger was started and the slug was

lowered quickly and smoothly and secured in its submerged position. The starting time and initial displacement were measured and recorded. During the test, data logger readings were checked periodically using the water-level meter to verify that all equipment was functioning correctly. The slug injection test was terminated after water levels had recovered to within 10 percent of the static water level measured prior to the slug injection or once 48 hours had elapsed.

After programming a new test on the data logger, the slug withdrawal test was initiated by starting the logger and smoothly removing the slug from the well. For the slug injection test, water levels were measured periodically with a water-level meter to verify the correct operation of the transducers and data logger. The slug withdrawal test was terminated after water levels returned to within 10 percent of the static water level prior to the slug injection test or once 48 hours had elapsed.

For baildown recovery tests, the transducer and data logger were set up as for slug injection and withdrawal tests. After setup and calibration, a 2-ft-long by 3-inch-diameter PVC bailer was used to bail water out of the well until the water level was at the bottom of the screened interval of the well. Bailed water was contained for later disposal in 55-gallon drums. When the appropriate water level was achieved, the data logger began to monitor the well recovery. Bailing rates and initial displacement were recorded and recovery was allowed to continue until water levels had recovered to within 10 percent of the static water level measured prior to the bailing or once 48 hours had elapsed.

After each test, all downhole equipment (slug, rope, bailer, transducers, and water-level meter) were decontaminated. Once each test was completed, the data were printed out on a field printer and the data files were downloaded from the data logger.

3.9.2 Aquifer Test Data Analysis

Estimates of hydraulic conductivity were obtained from the test data using conventional methods presented by Bouwer (1989) and Bouwer and Rice (1976). These methods were preferred for interpreting the test results because they are appropriate for partially penetrating wells in an unconfined aquifer. Slug test results are presented in Section 4.1.1.3. Falling-head curves, rising-head curves, aquifer analysis input parameters, and hydraulic conductivity results are presented in Appendix B.

3.10 PRESENT FUTURE USE INVESTIGATION

The human health and ecological risk assessment of SWMUs 1 and 25 was conducted using information on the present use of the site as well as assumptions about future use. During the RFI-Phase II field program information was collected through document review and TEAD employee interviews on present work patterns at the site, especially in areas where exposure to SWMU 1 and 25 contaminants could occur. The main present activities and operations near and inside the site are ranching and hunting to the south of the installation boundary, routine security patrols of the installation roads, and demilitarization operations at SWMU 31, which is to the northeast of SWMU 1. The uses of other surrounding areas were investigated in case the detected contaminant concentrations indicated a need for evaluating additional potentially exposed populations. Installation personnel were consulted about planned future uses of the installation. In the case of base closure, which is not currently anticipated, the most likely future use of this area would involve ranching.

3.11 QUALITY ASSURANCE/QUALITY CONTROL

3.11.1 Field Quality Assurance/Quality Control

Field quality control (QC) samples were collected at the time of sampling, in accordance with the RFI-Phase II Data Collection Quality Assurance Plan (EBASCO 1993b). The QC samples consisted of trip blanks, equipment rinse blanks, and field sample duplicates. Trip blanks are used as a check for sample contamination originating from sample transport, while equipment rinse blanks are a check on sampling device decontamination procedures. The field QC samples were analyzed in the same manner as actual samples regardless of the analytical methodologies; therefore, no analytical bias should exist.

3.11.1.1 Trip Blanks

Thirty-two trip blanks were analyzed during the RFI-Phase II sampling program, 7 for volatiles in soil and 25 for volatiles in water. One soil trip blank showed a trace detection of trichlorofluoromethane (Freon 11) at 2.00 micrograms per liter (μg/l). Three trip blanks for volatiles in water detected trace levels of chloroform ranging from 0.59 μg/l to 1.10 μg/l. These low-level detections are possibly a result of laboratory contamination and indicate that little or no contamination of volatile organic samples occurred during transport of samples from the field to the laboratory. A summary of trip blank detections can be found in Table 3.11-1.

3.10 PRESENT AND REASONABLE FUTURE USE INVESTIGATION

The human health and ecological risk assessment of SWMUs 1 and 25 was conducted using information on the present use of the site as well as assumptions about future use. During the RFI-Phase II field program information was collected through document review and TEAD employee interviews on present work patterns at the site, especially in areas where exposure to SWMU 1 and 25 contaminants could occur. The main present activities and operations near and inside the site are ranching and hunting to the south of the installation boundary, routine security patrols of the installation roads, and demilitarization operations at SWMU 31, which is to the northeast of SWMU 1. The uses of other surrounding areas were investigated in case the detected contaminant concentrations indicated a need for evaluating additional potentially exposed populations. Installation personnel were consulted about planned future uses of the installation. In the case of base closure, which is not currently anticipated, the most likely future use of this area would involve ranching.

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Analytical Group/ Analytes Detected	37-SP1	S-5	S-66-90	S-71-90
Volatile Organics: (µg/l)				
Trichlorofluoromethane (CCL3F)	2.00	LT (1.00)	LT (1.00)	LT (1.00)
Chloroform (CHCL3)	LT (0.50)	0.59	1.10	0.76

LT = Less than detection limit
µg/l = Microgram per liter

3.11.1.2 Rinse Blanks

Water used during drilling and decontamination operations was obtained from the water supply well 1-S. Samples of well 1-S water were collected in October 1992 and January 1993, and analyzed for the same suite of analytes planned for the RFI-Phase II field samples. The October 1992 sample was not analyzed for nitrate and alkalinity. The duplicate analysis of the supply well had detections of metals and anions only. No organic analytes were detected. A summary of the 1-S water supply well results can be found in Table 3.11-2.

Equipment rinse blanks were collected and analyzed for all analytes outlined in the RFI-Phase II sampling program to ensure that proper decontamination of field sampling equipment was achieved. The rinse blanks for VOCs, agent breakdown products, and cyanide revealed no evidence of carryover from sampling equipment for these contaminant groups. However, the rinse blank analyses for SVOCs, explosives, PCBs, metals, and anions indicated possible sample contamination carryover for these analyte groups.

Six rinse blanks were analyzed in the RFI-Phase II sampling program, four during soil sampling and two during groundwater sampling. Detections of chromium, selenium, aluminum, and arsenic were found in the soil sampling rinse blanks. In addition, the rinse blank results included two detections of 1,3,5-trinitrobenzene, one detection of PCB 1260, two detections of dimethylphenol, and one detection of fluoride. The results for the two groundwater sampling rinse blanks included detections of arsenic, selenium, bromide, fluoride, and bicarbonate. A correlation between field samples collected before and after each rinse blank could not be determined after a comparison of analytical results indicated no apparent field sampling cross-contamination. A summary of the rinse blank results can be found in Table 3.11-3. These compounds may have originated in the rinse water, but were not detected in samples from well 1-S.

3.11.1.3 Field Sample Duplicates

Six field sample duplicates, two groundwater and four soil, were collected during the RFI-Phase II sampling program. The purpose of the field duplicates was to determine the precision of the sampling and analysis system.

The field sample and duplicate sample from well S-5 showed detections of the same metals and anions, with the exception of nitrate, which was not reported in the S-5 field sample.

Table 3.11-2 Summary of Analytical Results for Water Supply Well 1-S

Analytical Group/ Analytes Detected	1-S 1/8/92(F)	1-S 10/14/93(F)
Metals: (µg/l)		
Sb	50.9	LT 60.0
Ba	61.9	70.9
Ca	78,600	92,000
Cu	LT 18.8	92.6
Fe	LT 77.5	525
Pb	LT 4.47	7.48
Mg	31,300	31,700
Mn	LT 9.67	9.71
K	3,710	1,560
Na	30,800	19,400
V	17.8	LT 27.6
Zn	LT 18.0	69.0
Anions: (µg/l)		
Cl	44,000	49,000
NO_3	2,000	NA
SO_4	31,700	30,400

µg/l = microgram per liter
F = filtered
LT = less than the lower certified reporting limit
NA = not analyzed
Please see Chemical Acronym List for acronym definitions.

Table 3.11-3 Summary of Analytical Results for Rinse Blanks

Analytical Group/ Analytes Detected	01-RB-1	01-RB-2	25-AM-58	25-ODC-92	S-19-88	S-67-90
Semivolatile Organics: (µg/l)						
DMP*	LT(1.5)	18.0	16.0	LT(1.5)	LT(1.5)	LT(1.5)
Explosives: (µg/l)						
135 TNB	LT(0.21)	0.821	0.303	LT(0.21)	LT(0.21)	LT(0.21)
PCBs: (µg/l)						
PCB260	LT(0.19)	LT(0.19)	0.23	LT(0.19)	LT(0.19)	LT(0.19)
Anions: (µg/l)						
Br	LT(1000)	LT(1000)	LT	LT(1000)	LT(1000)	10,000
F	LT(153)	LT(153)	LT	482.0	LT(153)	12,000
Metals: (µg/l)						
Al	LT(141)	241.0	232.0	LT(1.41)	LT(1.41)	LT(1.41)
As	LT(2.54)	LT(2.54)	2.7	LT(2.54)	2.88	280.0
Cr	97.0	LT(6.02)	LT	LT(6.02)	LT(6.02)	LT(6.02)
Se	6.37	6.89	6.45	LT(3.02)	4.05	22.0
Alkalinity: (µg/l)						
HCO_3	LT(10,000)	LT(10,000)	LT(10,000)	LT(10,000)	390,000	576,000

* = non-target analyte
µg/l = micrograms per liter
LT = less than the lower certified reporting limit
Please see Chemical Acronym List for acronym definitions.

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The field duplicate sample for S-67-90 could not be evaluated due to a potential mislabelling of sample containers at the time of collection. Analytical results for the field sample, duplicate, and rinse blank indicate similarities in the concentrations of metals and anions between the field sample and rinse blank. The levels of metals and anions in the duplicate more closely resemble analyses for samples collected from water supply well 1-S in October 1992 and January 1993. Organic compounds were not detected in any samples associated with well S-67-90.

The soil field sample for 01-HBA-93 showed a detection of mercury at two times the reporting limit. This detection was not reported in the field sample duplicate, and may be too close to the detection limit to show good reproducibility.

The field samples and duplicates for sites 25-AM-58 and 25-IDC-10 showed good reproducibility, although there was a detection of bis (2-ethylhexyl) phthalate in the field duplicate samples for both sites. Phthalates are common contaminants in field sampling programs and in laboratory analyses due to their widespread used as plasticizers.

In summary, the field duplicate results for the RFI-Phase II soil sampling analyses indicated that a high level of precision was achieved in both the field sampling procedures and the analytical methodologies. The concentration of analytes plotted at locations where field duplicates were collected is an average of the two detected values. If either the field sample or the duplicate was a nondetection, the detected value was plotted. Alternatively, if both values for the field sample and the duplicate were nondetections, the individual analysis was considered as a nondetection. The analytical results for all field and field duplicate samples can be found in the analytical data (Appendix F).

3.11.2 Laboratory Quality Assurance/Quality Control

Laboratory QC samples were analyzed with the actual samples to estimate and evaluate the information content of analytical data and to determine the necessity of corrective action for analytical procedures. Two types of QC were employed to satisfy both USAEC and EPA protocols.

3.11.2.1 Chemical Analytical Program

The RFI-Phase II samples were analyzed for VOCs, SVOCs, explosives, PCB compounds, metals, cyanide, alkalinity, agent breakdown products (ABP), thiodiglycol, and RCRA characteristics. The USAEC-approved methods used to perform these analyses are listed in Table 3.11-4. All analyses, except RCRA characteristics and alkalinity, utilized USAEC-approved methods.

The USAEC-approved methods are developed by independent laboratories for Army use only. These methods are developed from EPA methods, employing similar extraction and analytical techniques and achieving similar analyte detection limits. EPA SW-846 methods 8240, 8270, 8080, 8330, 6010, and 7000 were used as a basis for the development of USAEC methods for volatile and semivolatile organics, PCBs, explosives, and metals. USAEC methods are employed exclusively for agent breakdown products and thiodiglycol because there are no EPA-approved methods.

USAEC method detection limits are established during the method certification process. The detection limits for SW-846 methodologies are established by the individual laboratories with EPA guidance. Method detection limits for USAEC methods are comparable to EPA detection limits. However, method detection limits are always dependent upon sample matrix.

3.11.2.2 USAEC Method Quality Assurance/Quality Control

The QC samples associated with the USAEC methodologies included method blanks and QC spikes. A blank is an artificial sample designed to monitor the introduction of contaminants into a process. Two detections were reported for the method blank analyses associated with the RFI-Phase II samples. The detections of mesityl oxide, a nontarget semivolatile organic compound, had no effect on the qualification of sample data. The detection of potassium was significantly lower than the sample concentrations. The method blank is used to verify that the laboratory is not a source of sample contamination. The QC spike samples are analytical samples which have known amounts of control analytes added to standard matrices (determined by USAEC) to verify method performance and to provide precision and accuracy data. Three USAEC QC spikes per analytical batch are required by each Class I method. One spike concentration is at a level two times the lower certified reporting limit (CRL), and the other two concentrations are duplicate spikes at ten times the lower CRL. USAEC samples and QC spikes are analyzed in a specific order to ensure that all sample results are bracketed by QC results. Spike recovery data are plotted by lot designator on control charts to evaluate precision and accuracy. Trend and outlier analyses are performed to assess method control and data acceptance. The final acceptance of

Table 3.11-4 Summary of Approved Methods-USAEC/EPA Method Equivalents

Analytical Parameter	USAEC Method Number		EPA Method Number	
	Soil	Water	Soil	Water
Volatiles	LM23	UM20	8240	8240
Base-Neutral/Acid Extractable Semivolatiles	LM25	UM18	8270	8270
PCBs	LH17	UH02	8080	8080
Agent Breakdown Products - FC2A, EMPA, IMPA, MPA	NA	UT02	None	None
Thiodiglycol	NA	UW22	NA	None
Explosives	LW23	UW32	None	None
ICP Metals	JS12	SS10	6010	6010
Arsenic	B9	SD22	7060	7060
Lead	JD21	SD20	7421	7421
Selenium	JD20	SD21	7740	7740
Mercury	Y9	SB01	7471	7470
Cyanide	KF15	TF18	9010	9010
Anions - Br, Cl, F, SO_4	NA	TT10	NA	300.3
Nitrite/Nitrate	NA	TF22	NA	353.2
Bicarbonate	NA	99	NA	310.2
Phosphate	NA	TF29	NA	365.4

Note: Please see Chemical Acronym List for acronym definitions.
NA - Not Applicable
99 - Not a USAEC certified method

the analytical data provided by USAEC methodologies is the decision of USAEC and is based on the control charted QC data.

Other QA/QC acceptance criteria for USAEC methods include assuring that sample holding times are met. All sampling and analysis dates were compared to method-specific holding times. The verification of sample holding times reveals all analytical holding time criteria were met for the RFI-Phase II field samples.

Well samples for bicarbonate were analyzed using an EPA method that has not yet been certified by USAEC. Consequently, the method code for bicarbonate analysis is identified as method 99. However, the data in these lots are considered valid by USAEC.

3.11.2.3 Matrix Spike and Matrix Spike Duplicate Evaluation

QC for EPA methodologies consists of blanks, matrix spike (MS), matrix spike duplicate (MSD), and replicate samples. The laboratory blank is a reagent blank which is analyzed with every batch of samples to assure that no contamination has occurred during the extraction or analysis. One MS/MSD pair should be analyzed for every batch of 20 samples. The MS/MSDs are actual samples which are split three ways into a control sample and two other samples to be used as duplicates. The two sample duplicates are spiked with predetermined quantities of control analytes. For this project, the spiking levels for the MS/MSDs were the same as those used for the USAEC spikes. The control samples were analyzed to determine actual background analytes which were then subtracted from the spike data. The percent recoveries are calculated for detected analytes in the MS/MSDs and are used to assess analytical accuracy. In addition, the relative percent difference (RPD) between the MS and MSD is calculated and used to assess the analytical precision. Precision was also assessed by means of replicate laboratory sample analyses. Replicate samples were prepared by dividing a sample into two aliquots and analyzing each aliquot. The precision and accuracy data collected by EPA methodologies are not control charted due to the numerous different types of sample matrices. MS/MSDs were analyzed with both USAEC and EPA methodologies to provide information regarding sample matrices and the capability of the analytical methods to extract the analytes of interest from the matrices.

The analytical accuracy and precision control limits for EPA methodologies are established by the individual laboratories on an ongoing basis as part of a formal QC program in accordance with EPA guidelines. The ranges for accuracy and precision are established through continuous analysis of sample MS and MSDs. The EPA ranges for SW-846 methodologies can be found

within each method. However, for the most part these ranges have been determined through repetitive analysis of blank spiking and they differ from actual sample MS/MSD recovery data. The ongoing data quality checks are compared with established performance criteria to determine if the results meet the performance characteristics of the method. A basic statistical approach for environmental data is the use of plus or minus two standard deviations from the mean to yield a 95 percent confidence level for data. USAEC also utilizes this approach for establishing upper and lower control chart limits. The analytical precision as plotted for USAEC methods is analyte and method specific and ranges between 10 and 30 percent. However, USAEC MS/MSD recoveries were not assessed as part of data validation for this program.

4.0 CONTAMINATION ASSESSMENT

In this section, the history and physical characteristics of SWMUs 1, 25, and 37 are combined with RFI-Phase II and previous chemical analytical results to form the contamination assessment. This contamination assessment supports the risk assessment of SWMUs 1 and 25 in Section 5.0.

SWMU histories in this section include information from previous investigations (see Section 2.2) and data obtained from the disposal pit inventory completed as part of the RFI-Phase II field program. The sampling rationale and interpretation of the sampling data are based on information on SWMU history. A discussion of the physical characteristics of the environmental setting at each SWMU follows, incorporating data on geology, soil types, hydrology, and land uses obtained from the RFI-Phase II research and field activities. Information on physical site characteristics at each SWMU supports the contamination and risk assessments and the presence of human and ecological receptors. Next, chemical analytical results are interpreted in a presentation of soil, groundwater, and air contaminant distribution. Measured concentrations of metals in samples within the SWMU are compared to the background levels to distinguish contaminant releases from natural occurrences of these metals. Finally, this section contains a brief discussion of contaminant fate and transport.

4.1 RESULTS FOR SWMUs 1 AND 25

4.1.1 Background

4.1.1.1 Site Description and Waste Generation

SWMU 1 is 373 acres in area and SWMU 25 encompasses 1,105 acres. Both SWMUs are surrounded by barbed wire fences and locked gates. Across the perimeter road from these two SWMUs, the installation boundary is secured by a chain-link and barbed-wire fence and is regularly patrolled by security personnel.

SWMUs 1 and 25 include the area referred to in previous reports (see Section 2.2) as the burial area, demolition ground, burning/burial ground, and chemical demilitarization range. According to the Installation Assessment (USATHAMA 1979), this area was used to destroy and dispose of explosive and chemical munitions from 1945 to 1978. Table 2.1-1 lists explosive and propellant compounds and mixtures and Table 2.1-2 lists chemical agents that were handled and may have been disposed of at TEAD-S.

To facilitate evaluation of the RFI-Phase II data, SWMUs 1 and 25 have been subdivided into source areas according to type of wastes and disposal methods. The source areas were defined

using aerial photography interpretation and analysis of disposal pit inventory field observations. The source areas defined in SWMU 1 are the following:

- Covered and open trenches
- Incendiary burning area
- Crate burning area

The source areas defined in SWMU 25 are:

- High-explosive craters
- Windrows
- Ash mounds
- Incendiary burn area
- Covered trenches

The disposal pit inventory data for SWMUs 1 and 25 that form the basis of this subdivision are presented in Tables 4.1-1 and 4.1-2, respectively. IDFs that were sampled but not inventoried within these source areas and in undisturbed areas within these SWMUs are presented in Table 4.1-3. Undisturbed areas are areas without manmade materials or disturbed soils that were chosen to provide data outside IDFs where contamination was observed or expected. An estimate of explosive risk was made visually in each IDF. The risk was estimated to be nonexistent if no evidence of explosive ordnance disposal was seen on the surface. If some ordnance disposal was seen on the surface, but no explosives were visible, a low risk was assigned to the IDF. A moderate risk was assigned to a unit if no fuzed ordnance or explosives were visible, but there was strong evidence of explosive ordnance disposal on the surface (e.g., projectile casings marked "HE", detonation craters, propellant charge canisters, exploded grenades, exploded burster tubes). If there were visible fused and intact ordnance, bulk explosives, and intact fuses, or the area was adjacent to an active demolition range and contained scattered live ordnance, the area was given a high explosive risk.

Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
6	NA	Within TEAD-S, outside western SWMU boundary	Area of Sparse Vegetation	Uncovered	Healthy	None	No Activity	None	None	None
7	NA	IBA	2 Disposal Pits 1 Scrap Pile 1 Burn Pile	Pits - Covered Scrap Pile - Uncovered Burn Pile - Uncovered	Absent to Healthy	None	Ordnance Burial Ordnance Incineration Trash Disposal	M50A3 Incendiaries M74 Incendiaries 35-Gallon Barrels (Incendigel Containers) Wooden Crates Scrap Metal	Signs on covered disposal pit indicate buried chemical munitions as well as triangular signs with the numbers "24" and "25" on them	Medium
8	CBA-8 IAM-8 IAM-8A	CBA IBA	Burn Area	Uncovered	Stressed	None	Material Incineration	Metal Banding, Nails, Hinges, Parts of Wooden Crates	None	None
9	NA	CBA	Burn Area	Uncovered	Healthy	None	Wood Burning	Burned Crates Metal Banding	None	None
11	IAM-11	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Smoke Pots	None	Medium
12	NA	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Smoke Pots M47 Fire Bombs	None	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
13	IAM-13	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries 4.2-inch Mortars MK94 500 lb. Bombs	Some 4.2" mortars could have contained chemical agent	Medium
13A	NA	CAOT	Disposal Pit	Covered	Healthy	M50A3 Incendiaries	Ordnance Disposal and Burial	M50A3 Incendiaries	Two signs marked Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs marked with "20"	Medium
15	IAM-15	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Wooden Crates Scrap Metal	None	Medium
17	NA	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Wooden Crates Scrap Metal	None	Medium
18	NA	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Wooden Crates Scrap Metal 35-Gallon Barrels (Incendigel)	None	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

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IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
19	NA	IBA	Burn Area Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries 105mm Projectiles M2 4.2-inch Mortars	4.2-inch mortars could have contained chemical agent	Medium
21	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal	M50A3 Incendiaries 105mm Projectiles M2 4.2-inch Mortars MC1-GB Bomb Components	4.2-inch mortars and MC-1 could have contained chemical agent	Medium
24	NA	CAOT	Disposal Trench	Uncovered	Healthy	None	Ordnance Disposal	Ordnance Fragments (Small Amounts)	None	Low
25	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	One PSDQ 105mm Artillery Fuze	Ordnance Disposal	STB Containers 105mm Projectiles	One sign pole without placard	High
28	NA	CAOT	Disposal Pit	Covered	Absent to Healthy	None	Ordnance Disposal and Burial	None	A triangular sign marked "16" indicating M-70 mustard bomb burial (THAMA 1979)	Low
30	CBA-30 TA-301 TA-302	CAOT CBA	Disposal Trench	Uncovered	Sparse	None	Ordnance Disposal	War Gas Training Vial Ordnance Fragments M50A3 Incendiaries	War Gas Training Vial	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches
IBA Incendiary Burn Area
oz Ounce
WP White Phosphorous
CBA Crate Burn Area
IDF Individual Disposal Feature
STB Super Tropical Bleach
GB Isopropyl methylphosphonofluoridate (Sarin)
lb Pound
SWMU Solid Waste Management Unit
HE High Explosive
NA Not Applicable
UXO Unexploded Ordnance

Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
32	NA	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	None	Signs indicating chemical munitions burial: one warning Pit Contaminated with Toxic Chemical Munition and one triangular sign marked "2"	Low
33	NA	CAOT CBA	Disposal Trench and Burn Area	Uncovered	Absent to Healthy	None	Ordnance Disposal	M50A3 Incendiaries "DANC" Containers STB Containers M47 Fire Bombs 55-Gallon Drums Ammo Boxes Building Materials Wooden Crates	"DANC" and STB Decontamination Agents	Medium
36	NA	CAOT	Disposal Trenches and Burn Area	Covered	Healthy	None	Ordnance Disposal and Burial	Ordnance Fragments	Two Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs marked "19"	Low
38	NA	CAOT	Disposal Pit	Covered	Healthy	None	Ordnance Disposal and Burial	M50A3 Incendiaries 105mm Fragments	Two triangular signs marked "21"	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches	CBA Crate Burn Area	GB Isopropyl methylphosphonofluoridate (Sarin)	HE High Explosive
IBA Incendiary Burn Area	IDF Individual Disposal Feature	lb Pound	NA Not Applicable
oz Ounce	STB Super Tropical Bleach	SWMU Solid Waste Management Unit	UXO Unexploded Ordnance
WP White Phosphorous			

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Table 4.1-1 C.dnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
38A	NA	CAOT	Disposal Pit	Covered	Healthy	None	Ordnance Disposal and Burial	M50A3 Incendiaries	Two signs marked Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs marked "21"	Medium
39	NA	CAOT	Disposal Trenches	Covered	Healthy	None	Ordnance Disposal and Burial	M74 Incendiaries M2 4.2-inch Mortar Fragments	None	Medium
41	NA	CAOT	Disposal Pit and Burn Area	Uncovered	Absent (soil discolored)	None	Ordnance Disposal and Incineration	Smoke Pots Smoke Grenades Wooden Crates	None	Low
44	CP-44 DA-441 DA-442	CAOT	Disposal Pit Decontamination Area	Pit - Covered Decon - Uncovered	Sparse	None	Ordnance Disposal and Burial Decontamination of personnel and materials	STB Containers	One sign marked Danger, Pit Contaminated with Toxic Chemical Munitions and one triangular sign marked "10"	Low
45	NA	CAOT	Disposal Trench	Uncovered	Healthy	Two 105mm Projectiles with Fuzes	Ordnance Disposal	105mm Projectiles M2 4.2-inch Mortars 75mm Projectiles Wooden Crates Paint Cans	Some of the projectiles and 4.2-inch mortars may have contained chemical agent	High

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches
IBA Incendiary Burn Area
oz Ounce
WP White Phosphorous
CBA Crate Burn Area
IDF Individual Disposal Feature
STB Super Tropical Bleach
GB Isopropyl methylphosphonofluoridate (Sarin)
lb Pound
SWMU Solid Waste Management Unit
HE High Explosive
NA Not Applicable
UXO Unexploded Ordnance

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
46	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal	STB Containers 105mm Projectiles M50A3 Incendiaries	None	Medium
48	NA	CAOT	Disposal Trenches	Partially Covered	Healthy	One 105mm Chemical Projectile With Intact Burster Tube	Ordnance Disposal	105mm Projectiles M2 4.2-inch Mortars Ordnance Fragments	105mm Projectile With Intact Burster Tube	High
49	NA	CAOT	Disposal Trench and Burn Area	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	105mm Casings Ordnance Fragments M50A3 Incendiaries Burster Tubes	None	Medium
50	NA	CAOT	Disposal Trenches	Partially Covered	Healthy	None	Ordnance Disposal	105mm Fragments	None	Low
52	NA	CAOT	Disposal Trench and Burn Area	Partially Covered	Healthy	None	Ordnance Disposal and Incineration	105mm Cartridge Casings M50A3 Incendiaries STB Container	None	Low
57	NA	CAOT	Disposal Trench Disposal Pit	Uncovered Pit Covered	Healthy	None	Ordnance Disposal Incineration and Burial	M74 Incendiaries Smoke Pots WP Grenades Chlorinated Lime Containers Paint Cans	Two Danger, Pit Contaminated with Toxic Chemical Munitions Signs and two triangular signs marked "8"	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches
IBA Incendiary Burn Area
oz Ounce
WP White Phosphorous
CBA Crate Burn Area
IDF Individual Disposal Feature
STB Super Tropical Bleach
GB Isopropyl methylphosphonofluoridate (Sarin)
lb Pound
SWMU Solid Waste Management Unit
HE High Explosive
NA Not Applicable
UXO Unexploded Ordnance

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IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
58	MSD-58	CAOT	Disposal Trench	Uncovered	Absent to Healthy	M50A3 Incendiary Clusters	Ordnance Disposal Incineration and Burial	M50A3 Incendiary Clusters 55-Gallon Barrels (Heavily Reinforced) M74 Incendiaries STB Containers Ammo Boxes Metal Banding Wooden Crates Rolls of Aluminum CO_2 Fire Extinguishers First Aid Kits 105mm Packaging M17 Respirator Filters	M17 Respirator Filters 55-Gallon drums (heavily reinforced) may have contained chemical agent	Medium
59	MSD-59	CAOT	Disposal Trench and Burn Area	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	55-Gallon Barrels 55-Gallon Barrels (Heavily Reinforced) "DANC" Containers STB Containers Ammo Boxes M50A3 Incendiaries Rifle Grenades 105mm Packing Material	Some of the barrels may have stored chemical agent	Medium
60	IA-60	CAOT	Disposal Trench and Burn Area	Uncovered	Sparse	None	Ordnance Disposal and Incineration	55-Gallon Drums Smoke Pots M47 Fire Bombs 35-Gallon Drum (Incendigel)	Some of the drums may have stored chemical agent	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

Recycled Paper

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
61	NBA-61	CAOT	Disposal Trench	Uncovered	Healthy	None	Ordnance and Material Disposal	55-Gallon Barrels 35-Gallon Barrels (Incendigel) M47 Fire Bombs Propellant Canisters STB Containers Scrap Metal	None	Low
62	NA	CAOT	Disposal Trench	Uncovered	Healthy	None	Ordnance and Material Disposal and Incineration	M47 Fire Bombs Propellant Canisters Wooden Crates Scrap Metal	None	Low
63	NA	CAOT	Disposal Trench	Uncovered	Healthy	None	Little Evidence of Ordnance or Material Disposal	None	None	None
63A	CP-63A	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	None	One sign marked Danger, Pit Contaminated with Toxic Chemical Munitions and one triangular sign marked "26"	Medium
64	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal	M50A3 Incendiaries M2 4.2-inch Mortars 75mm Projectiles 105mm Projectiles STB Containers 57mm HE Projectiles 105mm Boosters	Some of the disposed ordnance could potentially contain chemical agent	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches
IBA Incendiary Burn Area
oz Ounce
WP White Phosphorous
CBA Crate Burn Area
IDF Individual Disposal Feature
STB Super Tropical Bleach
GB Isopropyl methylphosphonofluoridate (Sarin)
lb Pound
SWMU Solid Waste Management Unit
HE High Explosive
NA Not Applicable
UXO Unexploded Ordnance

Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
65	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal	75mm Projectiles 105mm Projectiles M50A3 Incendiaries STB Containers M48 Fuzes	None	Medium
67	NA	CAOT	Disposal Trench	Covered	Absent to Healthy	None	Ordnance Disposal and Burial	Ordnance Fragments	Two Danger, Buried Toxic Chemical Munitions signs and two triangular signs marked "11"	Medium
68	NA	CAOT	Disposal Trench	Covered	Healthy	One 3.5-inch Rocket Warhead-HE	Ordnance Disposal and Burial	Ordnance Fragments	One Danger, Pit Contaminated with Tube Chemical Munitions sign and two triangular signs marked "3"	Medium
69	NA	CAOT	Disposal Pit	Covered	Sparse	None	Ordnance Disposal and Burial	None	Three Danger, Pit Contaminated with Toxic Chemical Munitions signs and two triangular signs marked "7"	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
70	NA	CAOT	Disposal Pit	Covered	Sparse	None	Ordnance Disposal and Burial	M74 Incendiaries M50A3 Incendiaries 105mm Packaging Metal Banding	None	Low
71	NA	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	None	None	Low
72	NA	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	M50A3 Incendiaries	None	Low
72A	NA	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal Incineration and Burial	WP Grenades Rifle Grenades M17 Chemical Respirator Filters	Two signs marked Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs marked "9" M17 Chemical Respirator Filters	Medium
73	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	Two M2 4.2-inch Mortars with Burster Tubes (Possibly Chemical)	Ordnance Disposal and Incineration	55-Gallon Drums M2 4.2-inch Chemical Mortars M50A3 Incendiaries M74 Incendiaries M47 Fire Bombs Metal Containers Refrigerator Wooden Crates	Some of the drums and 4.2-inch mortars may have contained chemical agent	High

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
74	PCA-74	CAOT	Disposal Trench and Burn Area	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	55-Gallon Drums 155mm and 8-inch Projectile Propellants Charge Canisters Smoke Pots 105mm Packing Materials STB Containers	None	Low
76	NA	CAOT	Disposal Trenches and Burn Area	Uncovered	Healthy	None	55-Gallon and 35-Gallon Drum Disposal and Incineration	55-Gallon Drums 35-Gallon Drums(Incendigel) 105mm Packaging	4.2-inch Mortars may have contained chemical agent	Low
77	SPDA-77	CAOT	Disposal Trench and Burn Area	Uncovered	Healthy	None	Ordnance and Material Disposal and Incineration	M50A3 Incendiaries M74 Incendiaries Smoke Grenades Paint Cans Smoke Pots STB Containers 55-Gallon Drum (heavily reinforced) 105mm Shell Crates M9 Respirator Filters Ammo Boxes Scrap Metal	M-9 Respirator Filters The reinforced 55-Gallon barrels may have contained chemical agent	Low
79	NA	CAOT	Disposal Trench	Uncovered	Healthy	None	Ordnance Disposal	STB Containers M2 4.2-inch Mortars Wooden Crates	Some 4.2-inch Mortars may have contained chemical agent	Low
79A	NA	CAOT	Disposal Trench	Uncovered	Healthy	1 - 90mm HE Projectile	Ordnance Disposal	90mm HE Projectile Wooden Crates	None .	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

- * Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.
- ** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
80	IA-80	CAOT	Disposal Trench and Burn Area	Uncovered	Absent to Healthy	None	Disposal and Incineration of Ordnance and Material	55-Gallon Drums 35-Gallon Drums(Incendigel) Paint Cans 105mm Packaging Chemical Agent Thickener Containers	Chemical Agent Thickener Containers	Low
81	NA	CAOT	Disposal Trench	Uncovered	Sparse to Healthy	None	Ordnance Disposal	M47 Fire Bombs Sodium Hydroxide Drums M50A3 Incendiaries Ammo Boxes Smoke Pots Garbage 75mm Mortars Air Sampling Tubes	Air Sampling Tubes	Medium
82	MP-82	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal	M2 4.2-inch Mortars Wooden Crates 55-Gallon Barrels	Some of the 4.2-inch mortars may contain chemical agent	Medium
82A	NA	CAOT	Disposal Pit	Uncovered	Healthy	None	Ordnance Disposal and Incineration	M50A3 Incendiaries M2 4.2-inch Mortars Propellant Canisters Smoke Pots	Some 4.2-inch Mortars may have contained chemical agent	Medium
83	NA	CAOT	Disposal Trench	Uncovered	Absent to Healthy	M71 90mm HE Projectile	Ordnance Disposal	M50A3 Incendiaries 90mm Projectiles Ordnance Fragments	None	High

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches	CBA Crate Burn Area	GB Isopropyl methylphosphonofluoridate (Sarin)	HE High Explosive
IBA Incendiary Burn Area	IDF Individual Disposal Feature	lb Pound	NA Not Applicable
oz Ounce	STB Super Tropical Bleach	SWMU Solid Waste Management Unit	UXO Unexploded Ordnance
WP White Phosphorous			

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
84	HBA-84	CAOT	Disposal Trench	Uncovered	Sparse	None	Ordnance Disposal Refuse Incineration	M50A3 Incendiaries 55-Gallon Drums Wooden Crates War Gas Kit Transport Containers	War Gas Kit Transport Containers	Low
84A	NA	CAOT	Disposal Trench and Burn Area	Uncovered	Stressed to Healthy	None	Ordnance and Material Disposal	Tin Cans 55-Gallon Drums STB Containers War ID Kit Transport Case Scrap Metal	War ID Kit Transport Containers	Low
84B	NA	CAOT	Disposal Trench	Uncovered	Healthy	One 90mm HE Projectile Fuze	Ordnance Disposal	Base Plates Burster Tubes Ordnance Fragments	None	High
84C	NA	CAOT	Disposal Pit	Uncovered	Healthy	None	Ordnance Disposal and Incineration	M2 4.2-inch Mortars M50A3 Incendiaries	Some 4.2-inch mortar, may have contained chemical agent	Low
85	HBA-85	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	None	None	Low
86	NA	CAOT	Disposal Trench	Covered	Healthy	None	Ordnance Disposal and Burial	Ordnance Fragments	One triangular sign marked "1"	Low
86A	NA	CAOT	Disposal Trench	Covered	Healthy	One 90mm HE Projectile	Ordnance Disposal and Burial	90mm HE Projectile	Two triangular signs marked "15"	Medium

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT Covered and Open Trenches
IBA Incendiary Burn Area
oz Ounce
WP White Phosphorous
CBA Crate Burn Area
IDF Individual Disposal Feature
STB Super Tropical Bleach
GB Isopropyl methylphosphonofluoridate (Sarin)
lb Pound
SWMU Solid Waste Management Unit
HE High Explosive
NA Not Applicable
UXO Unexploded Ordnance

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Table 4.1-1 Ordnance Inventory and Explosive Risk Assessment for SWMU 1

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
86B	NA	CAOT	Disposal Trench	Covered	Healthy	One 3.5-inch Rocket with a HE anti-tank Warhead Fuzed	Ordnance Disposal and Burial	90mm HE Projectile	Two triangular signs marked "14"	High
88	IA-88 PCA-88	CAOT	Disposal Trench	Uncovered	Absent to Healthy	None	Ordnance Disposal and Incineration	35-Gallon Drums (Incendigel) 55-Gallon Drums 8-inch Propellant Charge Canisters Smoke Pots M50A3 Incendiaries STB Containers 105mm Packaging	Some of the drums and 4.2-inch mortars may have contained chemical agent The 8-inch Propellant Charge Canisters may have been used to overpack leaking chemical ordnance	Low
88A	NA	CAOT	Disposal Trench	Uncovered	Healthy	None	Ordnance Disposal and Incineration	M74 Incendiaries	None	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)

* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.

** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

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IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities*	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence*	Estimated Explosive Risk of IDF**
89	CP-89B MP-89 MP-89B MP-89C	CAOT	Disposal Trenches Disposal Pit	Uncovered Covered	Absent to Healthy	1,000 ± M2 4.2-inch Mortars, some of which may still contain HE or Chemical Agent	Ordnance Disposal	55-Gallon Drums 35-Gallon Drum (Incendigel) M2 4.2-inch Mortars M50A3 Incendiaries 105mm Projectiles	Two signs marked Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs with the number "6" and 4.2-inch mortars with burster tubes	High
89A	MP-89A	CAOT	Disposal Trench	Covered	Healthy	Two M2 4.2-inch Mortars with Burster Tubes	Ordnance Disposal and Burial	M2 4.2-inch Mortars Smoke Pots	Three signs marked Danger, Pit Contaminated with Toxic Chemical Munitions and two triangular signs with the number "5"	High
92	HBA-92	CAOT	Disposal Trenches	Covered	Sparse to Healthy	75mm Mortar-Fused HE	Ordnance Disposal and Burial	MK94 500 lb. Bomb Railroad Mine (Inert) 75mm Mortars Ordnance Fragments	None	High
93	HBA-93 HBA-93A	CAOT	Disposal Trench	Uncovered	Sparse to Healthy	None	Ordnance Disposal	Garbage 55-Gallon Drums Smoke Pots Railroad Mine	None	Low

SOURCE: IDF number for SWMU 1 was obtained during the RFI-Phase II for Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37, (Ebasco 1993b)
* Numbered triangular signs mark diposal features previously documented in the Installation Assessment (USATHAMA 1979); See Table 4.1-4.
** Based on visual surface inspection only.

CAOT	Covered and Open Trenches	CBA	Crate Burn Area	GB	Isopropyl methylphosphonofluoridate (Sarin)	HE	High Explosive
IBA	Incendiary Burn Area	IDF	Individual Disposal Feature	lb	Pound	NA	Not Applicable
oz	Ounce	STB	Super Tropical Bleach	SWMU	Solid Waste Management Unit	UXO	Unexploded Ordnance
WP	White Phosphorous						

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Table 4.1-2 Ordnance Inventory and Explosive Risk Assessment - SWMU 25

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
2	NA	CT	Leveled Area	N/A	Absent	None	Area once had a building on it that has been removed - the area has been leveled	None	None	None
5	NA	CT	Trench	Covered	Sparse/Healthy	None	Ordnance Destruction and Burial	Evidence of Incendiary Disposal Charred Steel Ordnance Fragments	None	Low
6	NA	CT	Trench	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments Incendiary Disposal	None	Low
7	CT-07	CT	Trenches and Burn Areas	Covered	Stressed to Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
9	NA	CT	2 Trenches and Burn Areas	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments Incendiary Disposal	None	Low
10	IDC-10 IDC-10A	CT	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
11	NA	CT	2 Trenches	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
14	NA	CT	2 Trenches and Burn Area	Partially Covered	Stressed to Healthy	None	Ordnance Incineration and Burial	Remnants of Ordnance Incineration	None	Low
15	NA	CT	Rocky Outcrop	N/A	Healthy	None	No Activity	None	None	None

* Based on visual surface inspection only

AM Ash Mounds; IDF Individual Disposal Feature; CT Covered Tenches; lb Pound; HEC High Explosive Craters; oz Ounce; IBA Incendiary Burn Area; NA Not Applicable; UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
16	NA	CT	Area of Sparse Vegetation	N/A	Healthy	None	No Activity	None	None	None
17	NA	CT	Area of Sparse Vegetation	N/A	Healthy	None	No Activity	None	None	None
18	NA	CT	Area of Sparse Vegetation	N/A	Healthy	None	No Activity	None	None	None
19	NA	CT	Trench	Covered	Sparse	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
20	NA	CT	Trench	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
21	NA	CT	Trench	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
22	NA	CT	Trench	Covered	Healthy	None	Ordnance Destruction and Burial	Ordnance Fragments	None	Low
23	NA	CT	Trench and Burn Area	Partially Covered	Sparse/Healthy	None	Ordnance Incineration and Burial	Ordnance Fragments Incendiary Residue	None	Low
24	NA	CT	Trench and Burn Area	Partially Covered	Healthy	None	Ordnance Incineration and Burial	Incendiary Residue	None	Low
25	NA	CT	Trench and Burn Areas	Covered	Stressed to Healthy	None	Ordnance Incineration and Burial	Ordnance Fragment s Incendiary Residue	None	Low

* Based on visual surface inspection only

AM Ash Mounds
IDF Individual Disposal Feature
CT Covered Tenches
lb Pound
HEC High Explosive Craters
oz Ounce
IBA Incendiary Burn Area
NA Not Applicable
UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

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Table 4.1-2 Ordnance Inventory and Explosive Risk Assessment - SWMU 25

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
26	NA	CT	Trench	Covered	Healthy	None	Ordnance Burial	Destroyed Ordnance	None	Low
27	NA	CT	Open Field	N/A	Healthy	None	No Activity	None	None	None
29	NA	CT	Trench and Burn Areas	Covered	Stressed to Healthy	None	Ordnance Incineration and Burial	Ordnance Fragments Incendiary Disposal	None	Low
30	NA	CT	Trench and Burn Areas	Covered	Stressed to Healthy	None	Ordnance Incineration and Burial	Evidence of Incendiary Disposal	None	Low
31	NA	CT	Trench and Burn Areas	Covered	Stressed to Healthy	None	Ordnance Incineration and Burial	Evidence of Incendiary Disposal	None	Low
32	NA	CT	2 Trenches	Covered	Sparse	None	Ordnance Burial	Ordnance Fragments Incendiary Residue	None	Low
33	NA	CT	Drainage	N/A	Healthy	None	No Activity	None	None	None
34	NA	CT	Open Field	N/A	Healthy	None	No Activity	None	None	None
38	NA	CT	Trench	Covered	Healthy	Five 4.2-inch Mortars with Burster Tubes	Ordnance Burial	Destroyed Ordnance 4.2" Mortars	4.2" Mortars have Chemical Markings	High
39	NA	CT	Area of Sparse Vegetation	N/A	Healthy	None	Little to No Activity	None	None	None
40	NA	IBA	Trench, Munition Piles, and Burn Areas	Covered	Stressed to Healthy	M50A3 Incendiaries	Ordnance Incineration and Burial	Ordnance, Fragment Incendiaries	None	Medium
41	NA	NA	Area of Sparse Vegetation	N/A	Healthy	None	No Activity	None	None	None

* Based on visual surface inspection only

AM Ash Mounds; IDF Individual Disposal Feature; CT Covered Tenches; lb Pound; HEC High Explosive Craters; oz Ounce; IBA Incendiary Burn Area; NA Not Applicable; UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

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IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
42	NA	HEC	Detonation Crater	Partially Covered	Healthy	None	Ordnance Detonation	Ordnance Fragments	None	Medium
47	NA	IBA	Former disposal area that has since been covered with heavy equipment.	Covered	Sparse	None	Unknown	None	No	Low
48	NA	IBA	Burn Area	Partially Covered	Stressed to Healthy	None	Ordnance Incineration	M50A3 Incendiaries (Majority Removed)	None	Low
51	NA	IBA	Burn Area	Partially Covered	Stressed to Healthy	None	Ordnance Incineration	M50A3 Incendiaries (Majority Removed) Napalm Canisters	None	Low
52	CT-52 NIA-52	IBA	2 Trenches and Burn Areas	Partially Covered	Sparse/Healthy	None	Ordnance Destruction and Burial	Destroyed Napalm Fire Bombs and M50A3 Incendiaries	None	Low
53	NA	IBA	Trench	Covered	Healthy	None	Ordnance and Material Destruction and Burial	M50A3 Incendiaries on Surface	None	Medium
55	NA	IBA	Detonation Crater	Partially Covered	Healthy	6 - M50A3 Incendiaries	Ordnance Detonation	Ordnance Fragments	None	Medium
58	AM-58	AM	Pit	Partially Covered	Stressed to Healthy	M50A3 Incendiaries	Ordnance Incineration	M50A3 Incendiaries MK94 500-lb. Bombs	Signs Warning of Buried Toxic Chemical Munitions	Medium
59	IBA-59	IBA	Burn Area	Partially Covered	Stressed to Healthy	M50A3 Incendiaries	Ordnance Incineration	Incendiaries	None	Low
60	IBA-60	IBA	Burn Area	Partially Covered	Stressed to Healthy	M50A3 Incendiaries	Ordnance Incineration	Incendiaries	None	Low

* Based on visual surface inspection only

AM Ash Mounds; IDF Individual Disposal Feature; CT Covered Tenches; lb Pound; HEC High Explosive Craters; oz Ounce; IBA Incendiary Burn Area; NA Not Applicable; UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

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Table 4.1-2 Ordnance Inventory and Explosive Risk Assessment - SWMU 25

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
65	IBA-65	IBA	Burn Area	Partially Covered	Stressed to Healthy	M50A3 Incendiaries	Ordnance Incineration	Incendiaries	None	Medium
66	NA	IBA	Burn Pile	Partially Covered	Stressed	M50A3 Incendiaries	Ordnance Incineration	M50A3 Incendiaries MK94 500-lb. Bombs	Signs Warning of Buried Toxic Chemical Munitions	High
75	NA	HEC	Detonation Crater	Partially Covered	Healthy	None	Ordnance Detonation	Ordnance Fragments	None	Medium
81	NA	HEC	Detonation Crater	Partially Covered	Healthy	None	Ordnance Detonation	Ordnance Fragments	None	Medium
82	NA	HEC	Detonation Crater	Partially Covered	Healthy	None	Ordnance Detonation	Ordnance Fragments	None	Medium
84	NA	HEC	Detonation Crater	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
87	NA	HEC	Detonation Craters	Partially Covered	Sparse	Approximately ¼ lb. Tritonal High Explosive	Ordnance Detonation	Ordnance Fragments	None	High
91	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
92	ODC-92	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
95	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
96	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium

* Based on visual surface inspection only

AM Ash Mounds
IDF Individual Disposal Feature
CT Covered Tenches
lb Pound
HEC High Explosive Craters
oz Ounce
IBA Incendiary Burn Area
NA Not Applicable
UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
99	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
100	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
101	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
103	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
104	NA	HEC	Detonation Craters	Partially Covered	Sparse	Approximately ¾ lb. Bulk Tritonal	Ordnance Detonation	Ordnance Fragments	No	High
105	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
107	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
108	ODC-108	HEC	Detonation Craters	Partially Covered	Sparse	Approximately 2 lb. Bulk Tritonal	Ordnance Detonation	Ordnance Fragments	No	High
109	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
110	ODC-110	HEC	Detonation Craters	Partially Covered	Sparse	Approximately 5 lb. Bulk Tritonal Approximately 1 oz. Bulk Comp B High Explosive	Ordnance Detonation	Ordnance Fragments	No	High

* Based on visual surface inspection only

AM Ash Mounds; IDF Individual Disposal Feature; CT Covered Tenches; lb Pound; HEC High Explosive Craters; oz Ounce; IBA Incendiary Burn Area; NA Not Applicable; UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

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IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
112	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
113	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	No	Medium
114	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
117	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	Yes, one sign indicating HAZMAT used in the area	Medium
118	NA	HEC	Detonation Craters	Partially Covered	Sparse	1 - Burster Tube filled with TNT	Ordnance Detonation	Ordnance Fragments	Burster Tube possibly from Chemical Ordnance	High
119	ODC-119	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
123	NA	HEC	Detonation Craters	Partially Covered	Sparse	Approximately 1 oz. Bulk TNT	Ordnance Detonation	Ordnance Fragments	None	High
124	NA	HEC	Detonation Craters	Partially Covered	Sparse/Stressed	None	Ordnance Detonation	Ordnance Fragments	No	Medium
125	NA	HEC	Detonation Craters	Partially Covered	Sparse	None	Ordnance Detonation	Ordnance Fragments	None	Medium
126	NA	HEC	Detonation Craters	Partially Covered	Sparse	Approximately 5 lb. Bulk Tritonal High Explosive	Ordnance Detonation	Ordnance Fragments	None	High

* Based on visual surface inspection only

AM Ash Mounds; CT Covered Tenches; HEC High Explosive Craters; IBA Incendiary Burn Area
IDF Individual Disposal Feature; lb Pound; oz Ounce; NA Not Applicable; UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

IDF Number	Sample Identification	Source Area	IDF Configuration	IDF Condition	Vegetation Status in Vicinity of IDF	UXO Present on Surface	Nature of Past IDF Activities	Materials Discarded in the IDF Visible on Surface	Chemical Agent Munition Disposal Evidence	Estimated Explosive Risk of IDF*
130	NA	IBA	Trench	Covered	Healthy	None	Ordnance and Material Destruction and Burial	Ordnance Fragments	None	Low
131	NA	HEC	Detonation Crater	Partially Covered	Healthy	3-M100 Series Bomb Fuzes 1 - 2.75 inch Rocket Fuze	Ordnance Detonation	Ordnance Fragments	None	Medium
132	NA	IBA	Trench	Partially Covered	Healthy	None	Ordnance Destruction and Burial	Residual Material from M50A3s	None	Low
133	NA	IBA	Trench and Burn Area	Partially Covered	Sparse/Healthy	None	Ordnance Destruction and Burial	Residual Material from M50A3s	None	Low
134	NA	IBA	Burn Area	Partially Covered	Stressed to Healthy	None	Ordnance Incineration	Remnants of Ordnance Incineration	None	Low
135	NA	IBA	Burn Area	Partially Covered	Stressed to Healthy	None	Ordnance Incineration	Remnants of Ordnance Incineration	None	Low

* Based on visual surface inspection only

AM Ash Mounds
IDF Individual Disposal Feature
CT Covered Tenches
lb Pound
HEC High Explosive Craters
oz Ounce
IBA Incendiary Burn Area
NA Not Applicable
UXO Unexploded Ordnance

SOURCE: IDF number for SWMU 25 was obtained from the RFI - Phase II Final Draft Data Collection Quality Assurance Plan for SWMUs 1, 25, and 37 (EBASCO 1993b)

Table 4.1-3 Soil Samples and Associated Source Areas for Individual Disposal Features that Were Not Inventoried

SWMU Number	Sample ID	Source Area
1	01-IBA-1	IBA
1	01-IBA-2	IBA
1	01-IBA-3	IBA
1	01-IBA-4	IBA
1	01-MHA-1	CAOT
1	01-MHA-2	CAOT
1	01-MHA-U	CAOT
1	01-MPVU1	CAOT
1	01-MPVU2	CAOT
1	01-MPVU3	CAOT
1	01-MPVU4	CAOT
1	01-NEAS1	NA
1	01-PBA-55	CBA
1	01-SEC1	NA
1	01-SPDA-99	CAOT
25	25-CT-08	CT
25	25-IBA-67	IBA
25	25-MA1	CT
25	25-MA2	CT
25	25-NWAS	NA
25	25-UA1	NA
25	25-UA2	NA
25	25-UA3	CT
25	25-WIND	WINDROWS

Notes:
CAOT Covered and Open Trenches
CBA Crate Burn Areas
CT Covered Trenches
IBA Incendiary Burn Areas
NA Not Applicable/Undisturbed Area

Figures 4.1-1 and 4.1-2 relate the more than 140 inventoried disposal features described in the tables to the resulting source area boundaries in SWMUs 1 and 25, respectively. Figure 4.1-3 illustrates the locations of additional ordnance outside of the disposal features. Table 4.1-4 presents the contents of covered pits in SWMU 1 that were documented previously in the Installation Assessment (USATHAMA 1979) and correlates the installation assessment pit number to the RFI-Phase II IDF number. Figure 4.1-4 presents the locations of the previously documented disposal features (DFs) as shown in the Installation Assessment.

SWMU 1 Covered and Open Trenches

The covered and open trenches source area is the largest source area in SWMU 1, covering all but the southwest and southern border of the SWMU (Figure 4.1-2). A 1952 aerial photograph (EPIC 1986) of the easternmost part of SWMU 1 showed eight ground scars and five trenches or pits. By 1959, a photo shows 46 trenches, approximately 25 pits, and several other unidentified features, indicating heavy use of the area. By 1966, five new trenches had been added in the central and west-central portion and some pits had been enlarged in the southeast corner of SWMU 1.

The Installation Assessment documents the relative locations and contents of 27 disposal pits that were part of the demolition ground and disposal pit area included in the SWMU 1 covered and open trenches area (USATHAMA 1979). The location and contents of these disposal pits are shown in Figure 4.1-4 and Table 4.1-4, respectively. The table also correlates the pit number in the Installation Assessment with the IDF numbers assigned in the RFI-Phase II. Items documented as destroyed and disposed of in these pits include cyanogen chloride (CK) and phosgene (CG) agents, M70 mustard bombs, M4A2 smoke pots, white phosphorous (WP) grenades, thermite, M50XA3 thermate bombs, one German Tabun (GA) bomb, M47 mustard bombs, boosters, "Poison Gas" (probably mustard), and base-generated trash. Some of the mustard may have been buried without first being burned. A 1972 Army document (Gatti 1972) reported that these mustard holding areas still showed signs of contamination.

Nineteen numbered markers were observed at IDFs that were inventoried during the RFI-Phase II field investigation. The markers were triangular metal signs, painted yellow with black numbers, and attached to metal posts approximately 6 ft high. These markers identify some of the 27 covered disposal pits documented previously in the Installation Assessment (USATHAMA 1979) on the basis of a 1959 TEAD disposition form. Since the RFI-Phase II transects did not pass by every disposal feature in SWMU 1, the fact that not all of the markers were found does

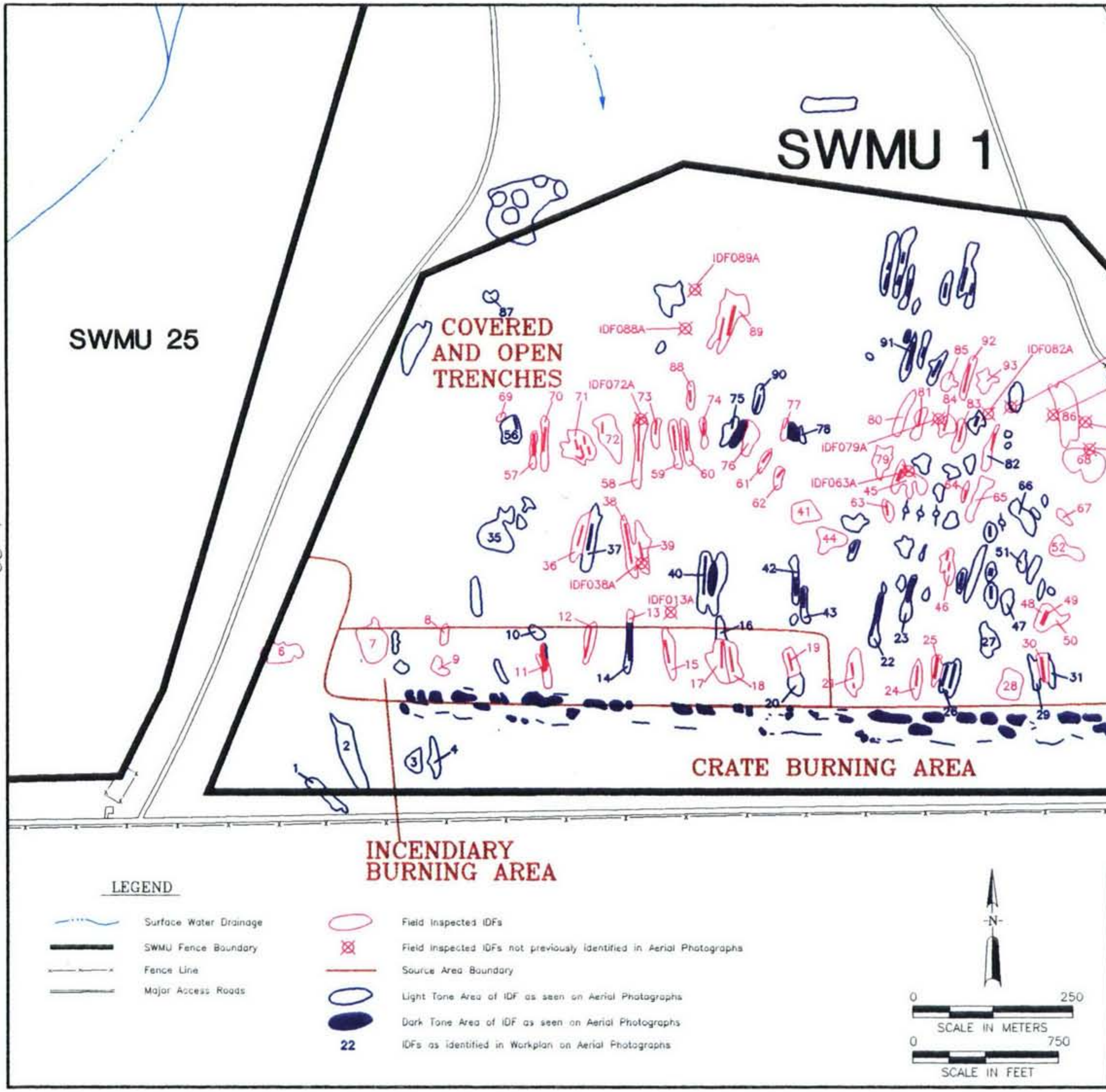

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Figure 4.1-1

Individual Disposal Features and Source Area Map of SWMU 1

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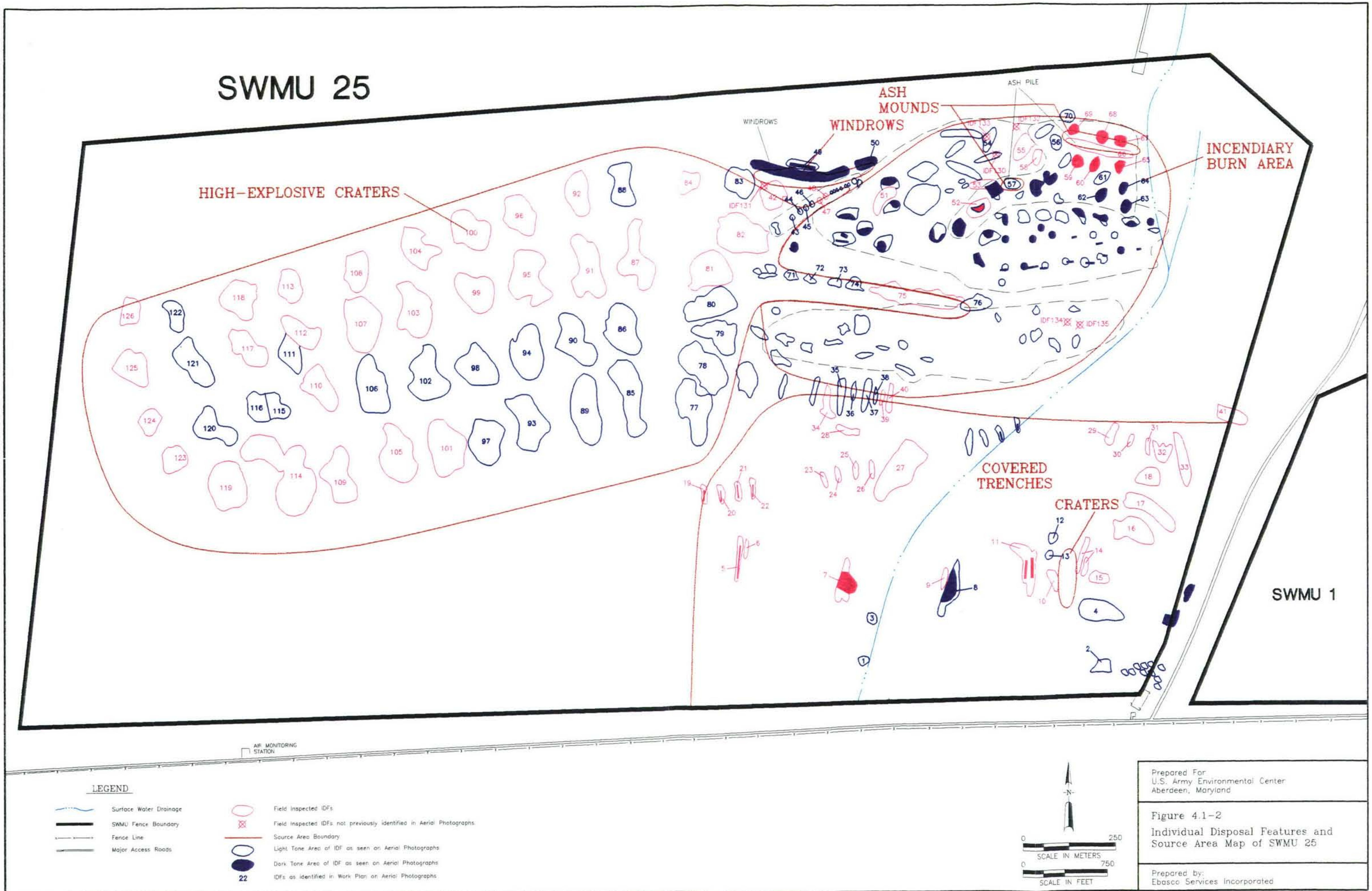

Figure 4.1-2
Individual Disposal Features and Source Area Map of SWMU 25

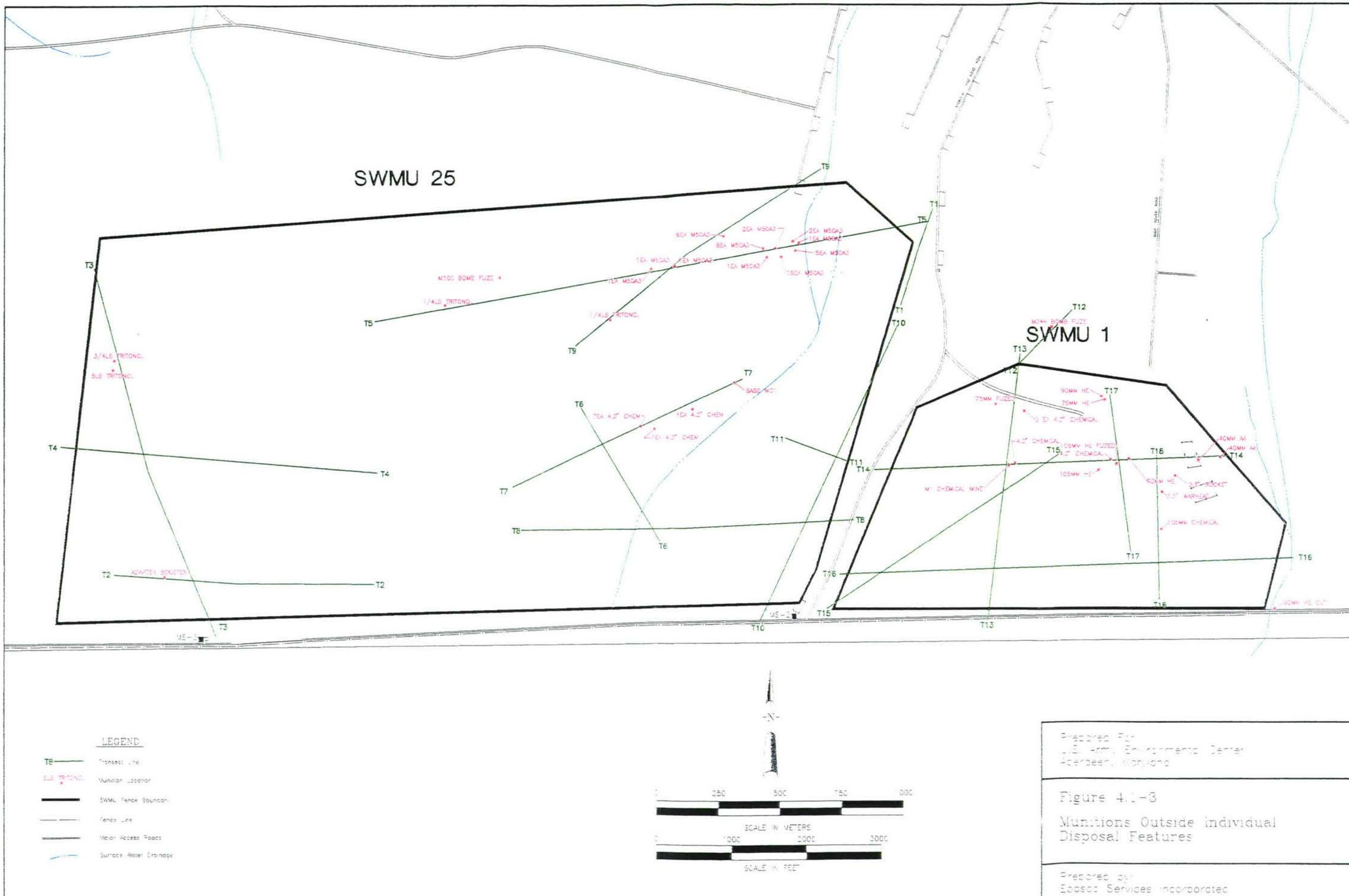

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Figure 4.1-3

Munitions Outside Individual Disposal Features

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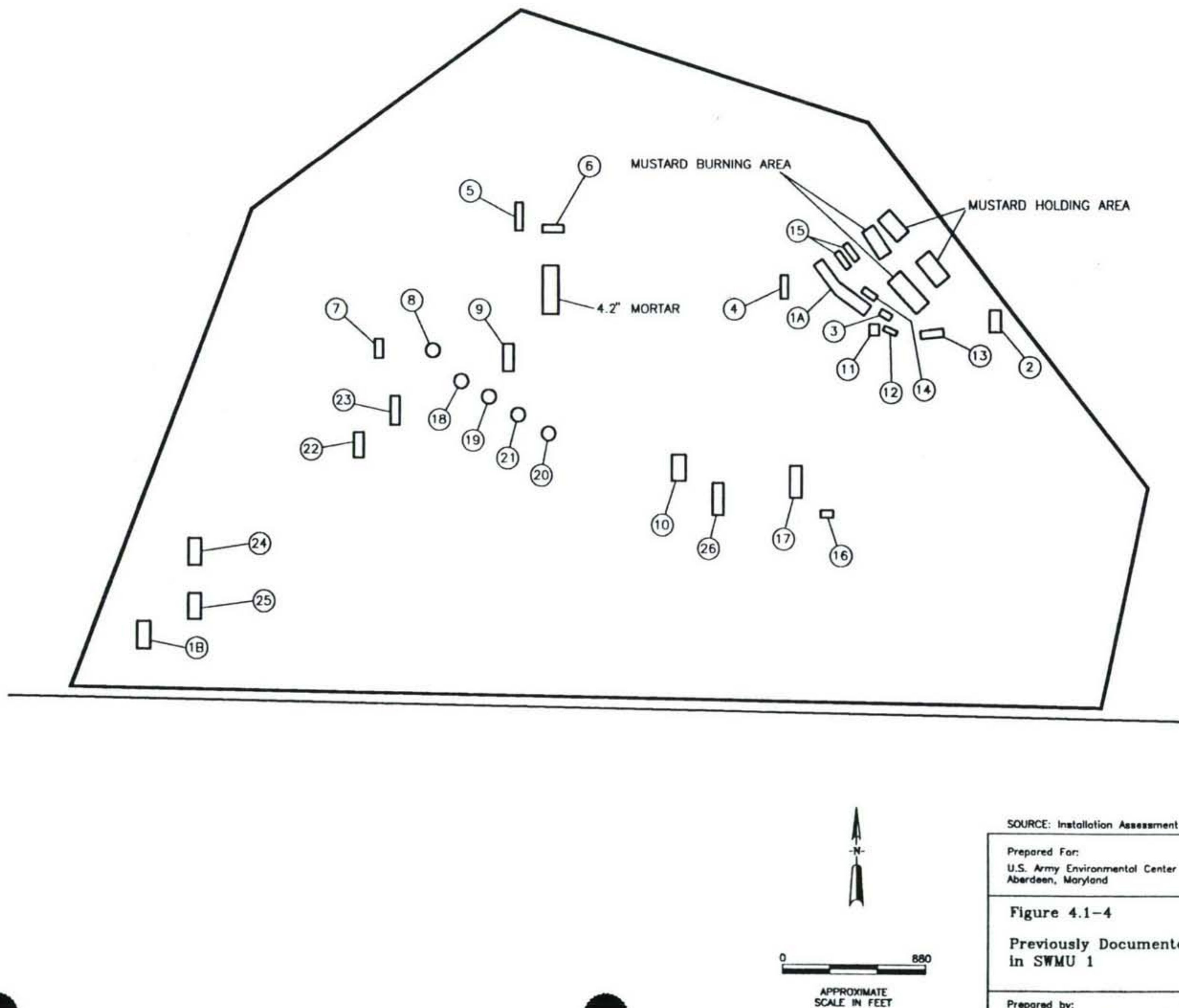
Table 4.1-4 Contents of Previously Documented Covered Pits in SWMU 1

Pit Number (Installation Assessment)	RFI-Phase II IDF Number	Contents
1a	86	M70 Mustard Bombs
1b	86	Mustard Bombs, M4A2 Smoke Pots, White Phosphorus grenades, trash
2	32	Thermite
3	68	Smoke Pots
4		M20 Bomb Clusters
5	89A	Smoke Pots
6	89	Smoke Pots
7	69	Smoke Pots
8	57	M50XA3 Bombs
9	72A	Smoke Pots
10	44	Thermite
11	67	Smoke Pots
12		Smoke Pots
13		M70 Mustard Bombs, one German Tabun Gas Bomb
14	86B	M70 Mustard Bombs
15	86A	M70 Mustard Bombs
16	28	M70 Mustard Bombs
17		M50XA3 Bombs
18		M50XA3 Bombs
19	36	M50XA3 Bombs
20	13A	M50XA3 Bombs
21	38, 38A	M50XA3 Bombs
22		M70 Mustard and M47 Bombs
23		M70 Mustard Bombs
24	7	Trash Pit
25	7	Boosters
26	63A	"Poison Gas" (probably mustard)

SOURCE: Installation Assessment (USATHAMA 1979).



SOURCE: Installation Assessment (USATHAMA 1979).

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Figure 4.1-4

Previously Documented Disposal Pits in SWMU 1

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not indicate that the rest of the 27 pits are unmarked. The shapes and locations of these pits shown in the Installation Assessment are reproduced in Figure 4.1-4. Information in the Installation Assessment on the contents of these pits is reproduced in Table 4.1-4, which has been amended to include the corresponding RFI-Phase II IDF numbers.

An ERTEC study (1982) indicates that Sarin (GB) and VX agents were disposed of in the demilitarization area and pits. However, the source of this information is not presented in the report. A former site employee who worked at TEAD-S during most of the period between 1951 and 1988 recalled that although mustard agent and one German GA bomb were disposed of in SWMU 1, only riot-control agents were disposed of in SWMU 25 (Barnes 1992).

Most of the above-listed munitions were burned on piles of dunnage so that the shells or containers would rupture and the contents would be exposed to the fire and destroyed. Gases (CK and CG) were released to the atmosphere during the process. The empty shells were burned and then buried.

The CK and CG disposal occurred in the late 1950s; the disposal of the other munitions occurred before 1959, the date of a disposition form that recorded information gathered through employee interviews conducted at that time. The last of a stored agent, hydrogen cyanide (AC), was incinerated in 1978. The Installation Assessment does not state whether incineration occurred at SWMU 1 or elsewhere. The AC containers were decontaminated at SWMU 1 by rinsing with caustic solution. Agent wastes and excess samples from the TEAD-S laboratory, possibly including mustard (H, HD, HT), AC, CK, and CG, were also burned at the demilitarization area (USATHAMA 1979).

During the RFI-Phase II disposal pit inventory, the following materials were observed in this area (Table 4.1-1): 57-mm, 75-mm, 90-mm, 105-mm, 155-mm, and 8-inch projectiles; M50A3 and M74 incendiaries; M47 firebombs; 105-mm burster tubes and boosters; M48 fuzes; M2 4.2-inch mortars; 35- and 55-gallon drums; STB containers; agent thickener containers; ordnance fragments; sodium hydroxide drums; decontaminating agent-noncorrosive (DANC) containers; chlorinated lime; rifles, smokepots, and WP grenades; ammo boxes; war gas transport containers; a railroad mine; MK94 500-pound bombs; M9 and M17 respirator filters; first aid kits; fire extinguishers; paint cans; propellant canisters; napalm cannisters; ME and GB bomb components; war gas training vial; smoke grenades; and miscellaneous trash. Some of the disposed ordnance,

such as the 4.2-inch mortars, and many of the drums may have contained agent. During the field inventory, field personnel did not handle, probe, or disturb any munitions or containers to evaluate if agent contamination remained. Signs posted at some of the pits were marked, "Danger, Pit Contaminated with Toxic Chemical Munitions."

Photographs taken during the field inventory of this area illustrate the number and condition of some of the munitions and other features in this source area. Figure 4.1-5 illustrates an open trench filled with 4.2-inch chemical mortar projectiles, and Figure 4.1-6 illustrates smoke pot disposal in an open trench. The exterior of the mortar projectiles is typically rusted and pitted from weathering or the caustic decontaminating agents that may have been applied during disposal. Decontaminating agents used include DANC (a mixture of sodium hydroxide and 1,1,2,2-tetrachloroethane) and super tropical bleach (sodium hydroxide alone). Such decontaminating agents may have been the contents of the 55-gallon drums pictured in Figure 4.1-7. Finally, Figure 4.1-8 illustrates the appearance of some of the closed trenches in this part of SWMU 1. Many of the closed pits are marked with chemical agent warning signs.

SWMU 1 Incendiary Burning Area

The incendiary burning area is located between the covered and open trenches area to the north and the crate burning area to the south (Figure 4.1-2). Three or four ground disturbances are visible on a 1952 aerial photograph. By 1959, nine trenches had been excavated. By 1966, the two easternmost trenches appear to be unused. Pits and trenches in this area were used for ordnance incineration and disposal. Materials observed in this area during the field inventory included M50A3 incendiaries, M74 incendiaries, smoke pots, M47 fire bombs, 4.2-inch mortars, MK94 500-pound bombs, wooden crates, scrap metal, 35-gallon barrels (incendigel containers), and 105-mm projectiles (Table 4.1-1).

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Figure 4.1-5

SWMU 1 Open Trench with 4.2-inch Mortars (IDF 89)

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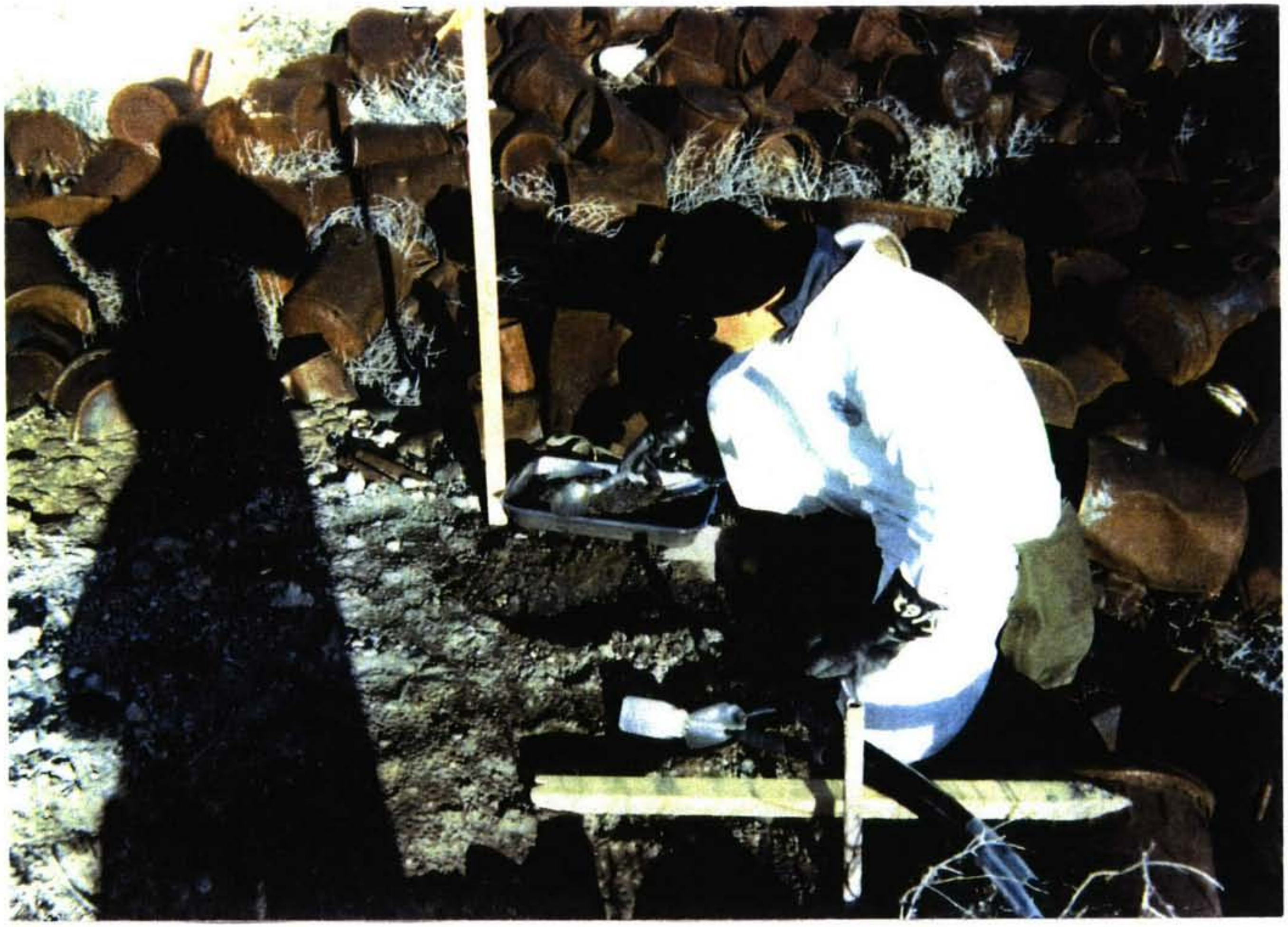

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Figure 4.1-6

SWMU 1 Open Trench with Smoke Pots (01-SPDA-77)

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Figure 4.1-7

SWMU 1 Open Trench with
55-gallon Drums (IDF-76)

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Figure 4.1-8

SWMU 1 Covered Trenches (IDF-72A)

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Figure 4.1-9 illustrates how incendiary munitions were demilitarized. First, Army personnel excavated a trench, piling clean soil at one end or to the side of the excavation. Then combustible portions of the incendiary bombs were apparently destroyed, and the ash residue was scraped to the open end of the trench. Finally, the ferrous metal bomb components were placed in the trench and possibly burned. A variety of materials and munitions such as napalm bombs were added to the trench to aid in burning.

SWMU 1 Crate Burning Area

The crate burning source area is located along the southern perimeter of SWMU 1 (Figure 4.1-2). Aerial photographs from 1959 and 1966 show two or more rows of more than 60 dark rectangular patterns within this area. The rectangular areas are approximately 100 ft long by 50 ft wide. Other dark, elongated, irregular patterns are also visible and appear to be related to the same operations as the rectangular areas. Materials observed in this area during the field inventory included charred wood and metal banding, hinges, screws, and handles. Based on the features observed at the site, it is believed that empty wooden crates were burned in this source area. A hard green residue resembling soapstone indicated that napalm may have been used to aid crate burning in parts of this area.

SWMU 25 High-Explosive Detonation Craters

The western part of SWMU 25 includes approximately 50 recently closed clusters of craters formed by open detonation of high-explosive munitions. Each cluster was about 3.5 acres in area (Figure 3.3-2; EPIC 1986). NUS (1987) estimated one of the larger craters to be 75 ft in diameter and 30 ft deep. Some of the explosion craters were deep enough to intersect the water table (USAEHA 1986). The earliest aerial photograph (1952) covers only the eastern border of this area. By 1959, a large number of craters are visible in the eastern portion of this area. The western portion of this area is not covered by aerial photographs until 1974. By that time, craters are visible throughout the entire area. These craters were closed between 1987 and 1990 (the time of the RFI-Phase I field program).

~~During the RFI-Phase II field inventory, small amounts of bulk tritonal, a secondary explosive, were found on the ground surface in this area (Figure 4.1-3). Otherwise, there is relatively little~~

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Figure 4.1-9

SWMU 1 Incendiary Burning Area Trench (IDF 13)

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Figure 4.1-10

SWMU 25 High Explosive Crater (IDF-116)

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During the RFI-Phase II field inventory, small amounts of bulk tritonal, a secondary explosive, were found on the ground surface in this area (Figure 4.1-3). Otherwise, there is relatively little debris remaining from the open detonation operation. Figure 4.1-10 shows how the craters appear after backfilling. Most are sparsely covered with opportunistic vegetation. Each former crater is still marked by slight subsidence.

SWMU 25 Windrows

Two windrows composed of metallic munitions parts are located in the north-central portion of SWMU 25. Aerial photographs show that these windrows appeared between 1952 and 1959 (EPIC 1986). The windrows contain tail sections of cluster bombs, cluster bars, nose plates, hangers, and fire-bomb casings. M50-type thermate bombs, some of which still contain live explosive charges, are also found in the windrows.

Figure 4.1-11 illustrates one of the RFI-Phase II sampling locations in the windrows. This photograph shows how the windrows, while mounded above the ground surface, actually occupy broad shallow trenches. Ferrous scrap metal from incendiary cluster bombs was placed in the trenches, doused with fuels, and burned. Soil samples were collected at the surface and below low areas in one of these trenches.

SWMU 25 Ash Mounds

In the northeastern part of the SWMU are two elongated mounds of ash-like material with interspersed pieces of shrapnel and scrap metal. The mounds are approximately 300 ft long, 40 ft wide, and 5 ft high (NUS 1987; EPIC 1986) and are relatively stable due to a weathered crust. This ash may be the result of burning the incendiary portions of cluster bombs, as cluster bomb parts are scattered throughout the ash. The ash may also have resulted from burning residues from incendiary munitions washout in SWMUs 21 and 22 (EBASCO 1993a). A sign that reads "Danger, Buried Contaminated Chemical Munitions" is posted at the edge of one of the mounds. At one time, TEAD-S personnel indicated that chemical agents had been burned and buried within the mounded areas (NUS 1987); however, a former employee (Barnes 1992) stated in an interview that only riot control agents were disposed of in SWMU 25. Apparent subsidence along the axis of the ash mounds appears to confirm the existence of a backfilled trench.

Figure 4.1-12 shows the configuration of the ash mounds and adjacent circular burn areas. The linear ash mound feature is actually composed of multiple piles of ash approximately the size of a small dump truck load. Ash may have been brought from adjacent circular burning areas, or from SWMUs 21 and 22 (once used for incendiary munitions washout), or both. Another view of the ash mound in Figure 4.1-13 shows how the ash is mixed with small amounts of ferrous

debris remaining from the open detonation operation. Figure 4.1-10 shows how the craters appear after backfilling. Most are sparsely covered with opportunistic vegetation. Each former crater is still marked by slight subsidence.

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SWMU 25 Ash Mounds

In the northeastern part of the SWMU are two elongated mounds of ash-like material with interspersed pieces of shrapnel and scrap metal. The mounds are approximately 300 ft long, 40 ft wide, and 5 ft high (NUS 1987; EPIC 1986) and are relatively stable due to a weathered crust. This ash may be the result of burning the incendiary portions of cluster bombs, as cluster bomb parts are scattered throughout the ash. The ash may also have resulted from burning residues from incendiary munitions washout in SWMUs 21 and 22 (EBASCO 1993a). A sign that reads "Danger, Buried Contaminated Chemical Munitions" is posted at the edge of one of the mounds. At one time, TEAD-S personnel indicated that chemical agents had been burned and buried within the mounded areas (NUS 1987); however, a former employee (Barnes 1992) stated in an interview that only riot control agents were disposed of in SWMU 25. Apparent subsidence along the axis of the ash mounds appears to confirm the existence of a backfilled trench.

Figure 4.1-12 shows the configuration of the ash mounds and adjacent circular burn areas. The linear ash mound feature is actually composed of multiple piles of ash approximately the size of a small dump truck load. Ash may have been brought from adjacent circular burning areas, or from SWMUs 21 and 22 (once used for incendiary munitions washout), or both. Another view of the ash mound in Figure 4.1-13 shows how the ash is mixed with small amounts of ferrous

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Aberdeen, Maryland

Figure 4.1-11

SWMU 25 Windrows (25-WIND)

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Aberdeen, Maryland

Figure 4.1-12

SWMU 25 Ash Mound and
Incendiary Burn Circles

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Ebasco Services Incorporated

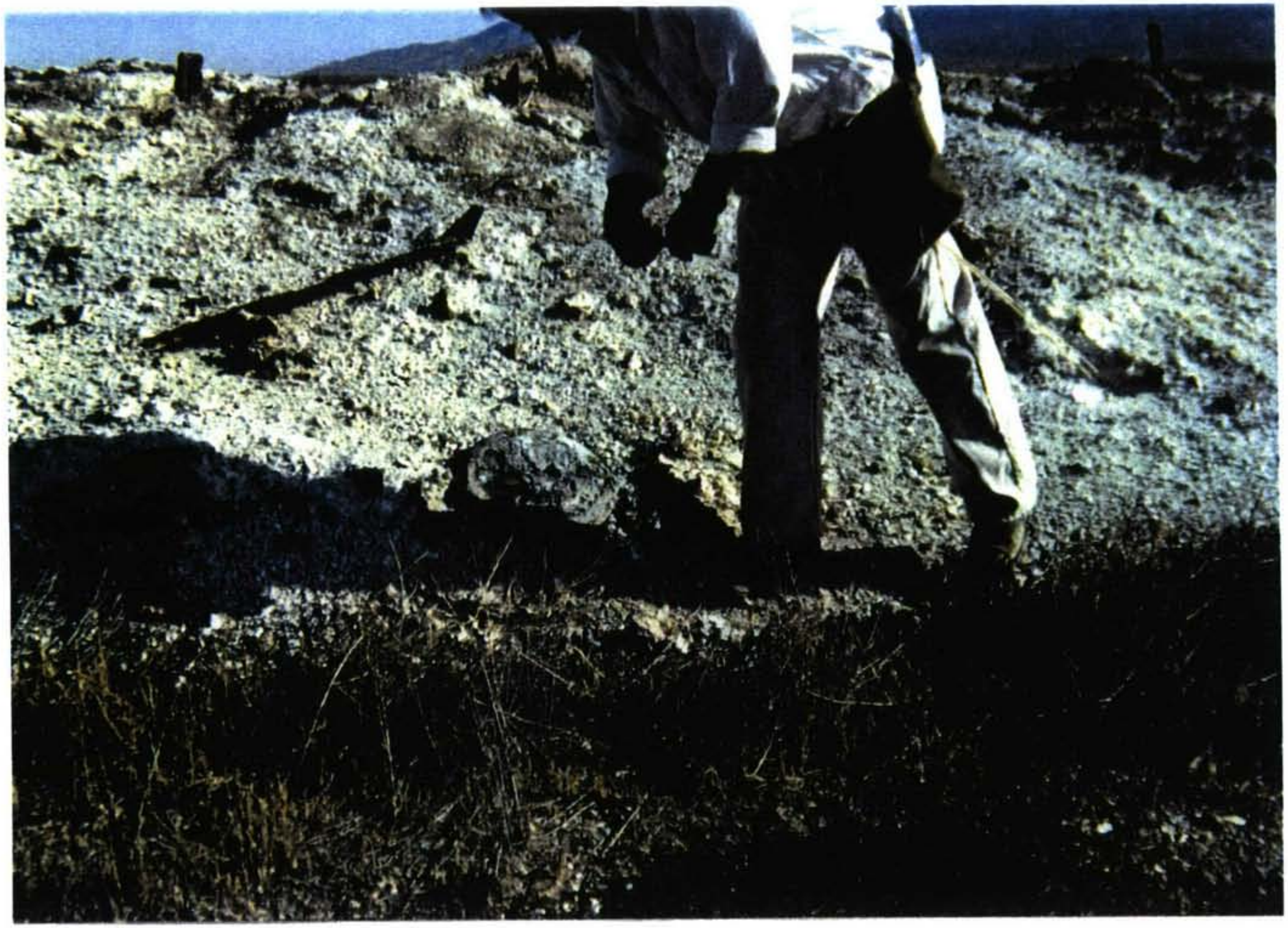

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Figure 4.1-13

SWMU 25 Ash Mound (IDF-66)

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scrap metal from the cluster bombs, although most of the ferrous metal was segregated and placed in the windrows.

SWMU 25 Incendiary Burn Source Area

The incendiary burn source area is located in the northeastern portion of SWMU 25. A line of smaller high-explosive craters extends into the west-central portion of the area. The ash mounds lie within the incendiary burn source area boundary (Figure 4.1-2). Large disturbed areas of dark smudges, possibly indicating burning, are visible on three 1959 aerial photographs in this area. In addition to burn areas, several trenches are present in this source area. Most of the trenches are located in the northern portion of the area and most of the trenches have been backfilled. These IDFs are typically circular areas where incendiary cluster bombs were burned on the ground. Most of the ash residue and ferrous scrap have been cleared away (probably placed in the ash mounds and windrows). M50A3 incendiaries and residual M50A3 material were observed at most of these IDF locations (Table 4.1-2). MK94, 500-pound bombs were present at IDF 66 (a burn pile) and IDF 58 (a partially covered pit). Signs at these two IDFs warned of buried toxic chemical munitions.

Intact incendiary bomblets are scattered throughout this area. The bomblets are the individual hexagonal-shaped components of the cluster bomb and were designed to be banded together in a cluster that was then fitted with a nose cone and fins for better aerodynamic performance. On impact, the cluster would burst apart into individual bomblets. Some of the cluster bombs of the type found in this source area included a small time-delayed explosive charge to discourage enemy firefighters from approaching the bombs or bomblets and attempting to remove them from a target. RFI field crews inferred that during demilitarization of these bombs in SWMU 25, detonation of these small explosive charges may account for the bomblets scattered outside of the areas used for incendiary burning. These bomblets did not burn and are still live.

SWMU 25 Covered Trenches Source Area

The covered trenches source area occupies the southeastern corner of SWMU 25. A small linear chain of detonation craters is located in the east central portion of this source area. By 1959, aerial photographs show 30 trenches visible in an area criss-crossed by roads. Three new trenches were evident in the 1966 photographs (EPIC 1986). Presently, nearly all the trenches have been covered (Figure 4.1-14). Ordnance fragments were the most common materials observed at the surface during the RFI-Phase II field program. More than half of the IDFs visited showed evidence of ordnance incineration.

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Figure 4.1-14

SWMU 25 Covered Trench (IDF-9)

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4.1.1.2 Geology and Soils

The upper stratigraphic units beneath SWMUs 1 and 25 are composed chiefly of lacustrine silt and clay deposits. The total thickness of these deposits in this area is unknown. Well S-95-92, located along the southern border of SWMU 25, is 131 ft deep and penetrates deeper strata than any other well in SWMUs 1 and 25. All of the sediments penetrated in this well appear to be fine-grained lacustrine deposits. Isolated gravel lenses that occur in the ridge that separates SWMUs 1 and 25 may represent remnants of alluvial fan deposits. Gravel lenses present in the unsaturated zone are located approximately 40 ft or more above the water table. Minor lenses and layers of clayey to silty fine sands are also present in the lacustrine sediments. These gravel and sandy layers may serve as conduits and preferred pathways for groundwater migration; however, they do not appear to extend horizontally for more than a few hundred feet. The moisture content of these sediments is generally very low. The consistency of the silt and clay is mostly stiff to hard and increases with depth except in minor zones where higher moisture contents are present. Several soil types have developed atop these geologic parent materials and are described below.

Unpublished information on soil types at TEAD-S was obtained from the USDA Soil Conservation Service (SCS) in 1993 (SCS no date). Soil types mapped at SWMU 1 include Cliffdown gravelly sandy loam and Tooele fine sandy loam. Cliffdown soils present are in the eastern and western portions and Tooele soil occupies the central portion of SWMU 1 (Plate 1). Cliffdown soil, the coarser-grained soil type in SWMU 1, exhibits moderately rapid permeability, is very slightly to slightly saline, moderately alkaline at the surface, and increases in alkalinity with depth. Tooele soil is somewhat less coarse than Cliffdown soils, but also exhibits moderately rapid permeability. Tooele soil is slightly saline and moderately alkaline at the surface, and increases in salinity and alkalinity with depth (to 60 inches).

Some of the characteristics of these soils affect the future uses that could be considered for the area. Cliffdown and Tooele soil units are suitable for wildlife habitat and irrigated crops of alfalfa, pasture, barley, orchards (Cliffdown only), and corn silage (Tooele only). Gravels in Cliffdown soils limit their suitability for tillage. Cliffdown soil has poor suitability and Tooele soil has fair suitability for livestock grazing due to low-to-moderate forage production. Rangeland seeding suitability for both units is very poor. Water and wind erosion hazards are moderate for both units.

The principal soil types mapped at SWMU 25 include Tooele fine sandy loam, Taylorsflat loam, Timpie silt loam, Skumpah silt loam saline, and Skumpah silt loam wet substratum, saline. Small areas of SWMU 25 are covered by Bramwell silt loam and Cliffdown gravelly sandy loam (Plate 1).

The Tooele unit described above covers most of the incendiary burn and ash mound area within SWMU 25. Taylorsflat soil covers the northeastern corner of SWMU 25 and exhibits moderately low permeability. The Taylorsflat unit is moderately alkaline at the surface and slightly to moderately saline and more strongly alkaline in underlying units. Timpie silt loam covers the southeastern corner of SWMU 25 in the covered trenches area and, like the Taylorsflat unit, has moderately low permeability. The upper zone of the Timpie unit is slightly saline, whereas the deeper zones are strongly saline. The Skumpah unit trends northwest to southeast across the central portion of SWMU 25 and has moderately low permeability. The upper few inches are slightly saline, but accumulations of sodium salts and gypsum ($CaSO_4 \cdot 2H_2O$) in underlying layers make these the most saline and alkaline soils in SWMU 25. A small area in the northwest corner of SWMU 25 is covered by Bramwell silt loam. This soil is somewhat poorly drained and has low permeability. Bramwell soil is slightly to moderately saline. Cliffdown gravelly sandy loam covers a small area near the southeastern corner of SWMU 25 and is discussed above.

The soil units in SWMU 25 are suitable for wildlife habitat and, with the exception of the Skumpah units, for irrigated croplands. Small areas of Skumpah soils can be reclaimed, but production is generally limited by the high salt and alkali content and a lack of irrigation water. Bramwell soil is suited to irrigated crops after the salt and alkali content are reduced. Suitable irrigated crops include alfalfa, pasture, barley, and corn silage. The potential of these units for livestock grazing is good for the Bramwell and Taylorsflat units, fair for the Timpie and Tooele units, and poor for the Cliffdown and Skumpah units. The potential for rangeland seeding is fair for the Bramwell and Taylorsflat units and generally very poor for the other soil units. Water and wind erosion hazards are moderate for all soil units.

In addition to the soil information provided by the SCS, a total of 40 samples from both SWMU 1 and 25 were submitted for geotechnical and geochemical analyses. Samples from undisturbed areas correspond to the soil types described above. Samples from excavated disposal features can be expected to vary from the surface soil found at natural grade. The analyses of these samples include grain-size distribution (USCS classification), total organic carbon content,

pH, moisture content, liquid limit, and plasticity index. The results of these analyses are presented in Appendix A3.

4.1.1.3 Hydrology

Surface water runoff at SWMUs 1 and 25 generally occurs only during spring snowmelt or large rainfall events. Snowmelt in the spring of 1993 flowed south from SWMU 1 across the southern TEAD-S boundary and onto adjacent ranch land. During this time, snowmelt drainage was sufficient to erode small channels. When runoff occurs, surface water also ponds in open or subsided trenches and pits. In the past when more trenches and pits were open, more ponding may have occurred. Direct communication between surface water and groundwater occurred in the high explosive crater source area of SWMU 25, where the craters were deep enough to intersect the underlying water table. The craters were backfilled between 1987 and 1990, eliminating the direct communication between surface water and groundwater. Groundwater in SWMUs 1 and 25 is derived mainly from regional flow originating in the Oquirrh and Onaqui Mountains, even though recharge volumes may be small.

Groundwater recharge from surface water at TEAD-S is probably minimal because soil moisture contents are insufficient to exceed the field capacity of the soils; however, infiltration of water that collects in disposal pits or that enters macropores and shrinkage cracks may be significant in leaching contaminants to groundwater. Water is also lost to evaporation both before and after infiltration. Groundwater discharges primarily as underflow beneath the southern border of TEAD-S toward Five Mile Pass.

To better understand the hydrogeology of SWMUs 1 and 25, it may be useful to review the field conditions observed and the techniques used during well drilling in SWMUs 1 and 25. The depth to groundwater in SWMU 1 varies from approximately 30 to 100 ft (Tables 4.1-5 and 4.1-6; and Figure 4.1-15). Depth to groundwater in SWMU 25 is approximately 15 to 69 ft. The clay-rich sediments in this area have high specific retention, releasing only small quantities of water through gravity drainage. Accordingly, it is typically difficult to recognize the water table during well drilling. Hollow-stem auger and air rotary drilling techniques were used to install wells in this area to ensure that the water table could be located. However, in SWMUs 1 and 25 some boreholes remained open for many hours before measurable quantities of water were observed. Even when measurable water is present, it may be difficult to determine the depth of the producing interval. Although wells in this area were targeted to measure the first (shallowest) water-bearing zone, several different zones may have been screened and measured. Due to these

Table 4.1-5 TEAD-S Water Levels, February 1993

Well	Ground Surface Elevation*	Top of PVC Elevation* (above msl)	Measured Depth to Water*	Elevation of Water* (above msl)	Depth From Ground Surface*
S-4	5,064.00	5,066.64	58.35	5,008.29	55.71
S-5	5,048.60	5,052.07	36.62	5,015.45	33.15
S-6	5,036.90	5,039.93	18.61	5,021.32	15.58
S-7	5,045.90	5,048.77	29.88	5,018.89	27.01
S-18-88	5,035.87	5,037.68	21.49	5,016.19	19.68
S-19-88	5,057.73	5,059.79	37.60	5,022.19	35.54
S-64-90	5,042.70	5,045.45	23.56	5,021.89	20.81
S-65-90	5,035.40	5,038.17	18.57	5,019.60	15.80
S-66-90	5,056.20	5,058.86	38.89	5,019.97	36.23
S-67-90	5,036.90	5,038.86	20.31	5,018.55	18.35
S-68-90	5,057.20	5,059.22	41.29	5,017.93	39.27
S-69-90	5,102.00	5,104.42	102.82	5,001.60	100.40
S-70-90	5,058.60	5,060.95	46.08	5,014.87	43.73
S-71-90	5,053.80	5,056.24	42.52	5,013.72	40.08
S-93-92	5,070.14	5,072.95	66.03	5,006.92	63.22
S-95-92	5,043.98	5,046.06	29.01	5,017.05	26.93
S-96-92	5,069.25	5,071.51	69.30	5,002.21	67.04
S-97-92	5,083.96	5,086.54	71.07	5,015.47	68.49
S-98-92	5,046.31	5,048.76	30.31	5,018.45	27.86
S-99-92	5,046.54	5,048.94	31.79	5,017.15	29.39
S-100-92	5,074.67	5,076.88	52.95	5,023.93	50.74
S-101-92	5,056.81	5,059.32	41.83	5,017.49	39.32
S-102-92	5,051.54	5,053.76	36.29	5,017.47	34.07

Notes:
* All values in feet
msl - mean sea level

Table 4.1-6 TEAD-S Water Levels, August 1993

Well	Ground Surface Elevation*	Top of PVC Elevation* (above msl)	Measured Depth to Water*	Elevation of Water* (above msl)	Depth from Ground Surface*
S-4	5,064.00	5,066.64	58.12	5,008.52	55.48
S-5	5,048.60	5,052.07	35.64	5,016.43	32.17
S-6	5,036.90	5,039.93	17.72	5,022.21	14.69
S-7	5,045.90	5,048.77	24.37	5,024.40	21.50
S-18-88	5,035.87	5,037.68	21.06	5,016.62	19.25
S-19-88	5,057.73	5,059.79	37.07	5,022.72	35.01
S-64-90	5,042.70	5,045.45	21.59	5,023.86	18.84
S-65-90	5,035.40	5,038.17	17.95	5,020.22	15.18
S-66-90	5,056.20	5,058.86	36.95	5,021.91	34.29
S-67-90	5,036.90	5,038.86	19.32	5,019.54	17.36
S-68-90	5,057.20	5,059.22	40.89	5,018.33	38.87
S-69-90	5,102.00	5,104.42	102.25	5,002.17	99.83
S-70-90	5,058.60	5,060.95	45.33	5,015.62	42.98
S-71-90	5,053.80	5,056.24	40.84	5,015.40	38.40
S-93-92	5,070.14	5,072.95	66.03	5,006.92	63.22
S-95-92	5,043.98	5,046.06	28.51	5,017.55	26.43
S-96-92	5,069.25	5,071.51	68.12	5,003.39	65.86
S-97-92	5,083.96	5,086.54	70.49	5,016.05	67.91
S-98-92	5,046.31	5,048.76	26.55	5,022.21	24.10
S-99-92	5,046.54	5,048.94	30.07	5,018.87	27.67
S-100-92	5,074.67	5,076.88	51.93	5,024.95	49.72
S-101-92	5,056.81	5,059.32	39.98	5,019.34	37.47
S-102-92	5,051.54	5,053.76	34.40	5,019.36	32.18

Note: * - All values in feet
1 msl - mean sea level

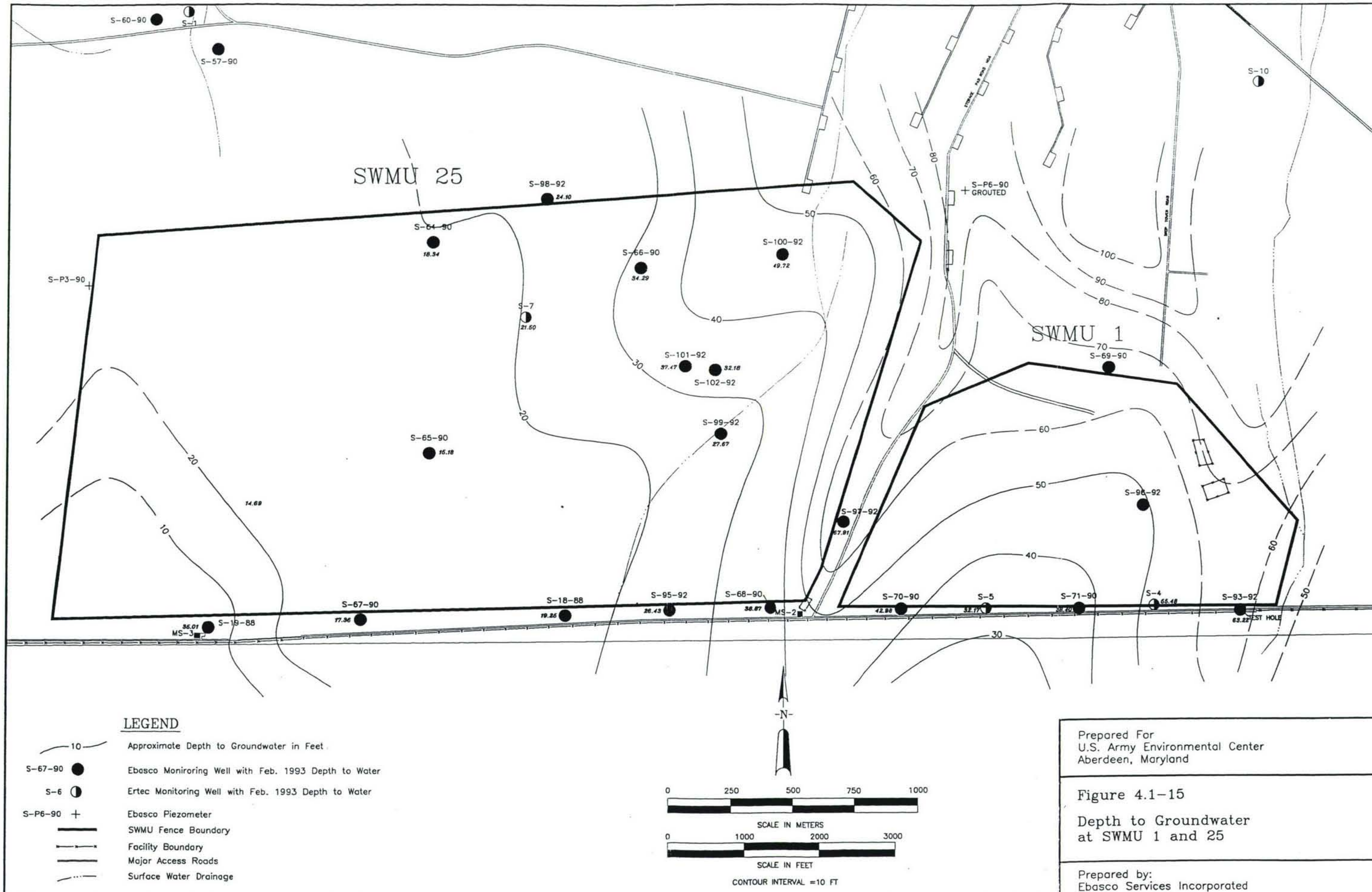


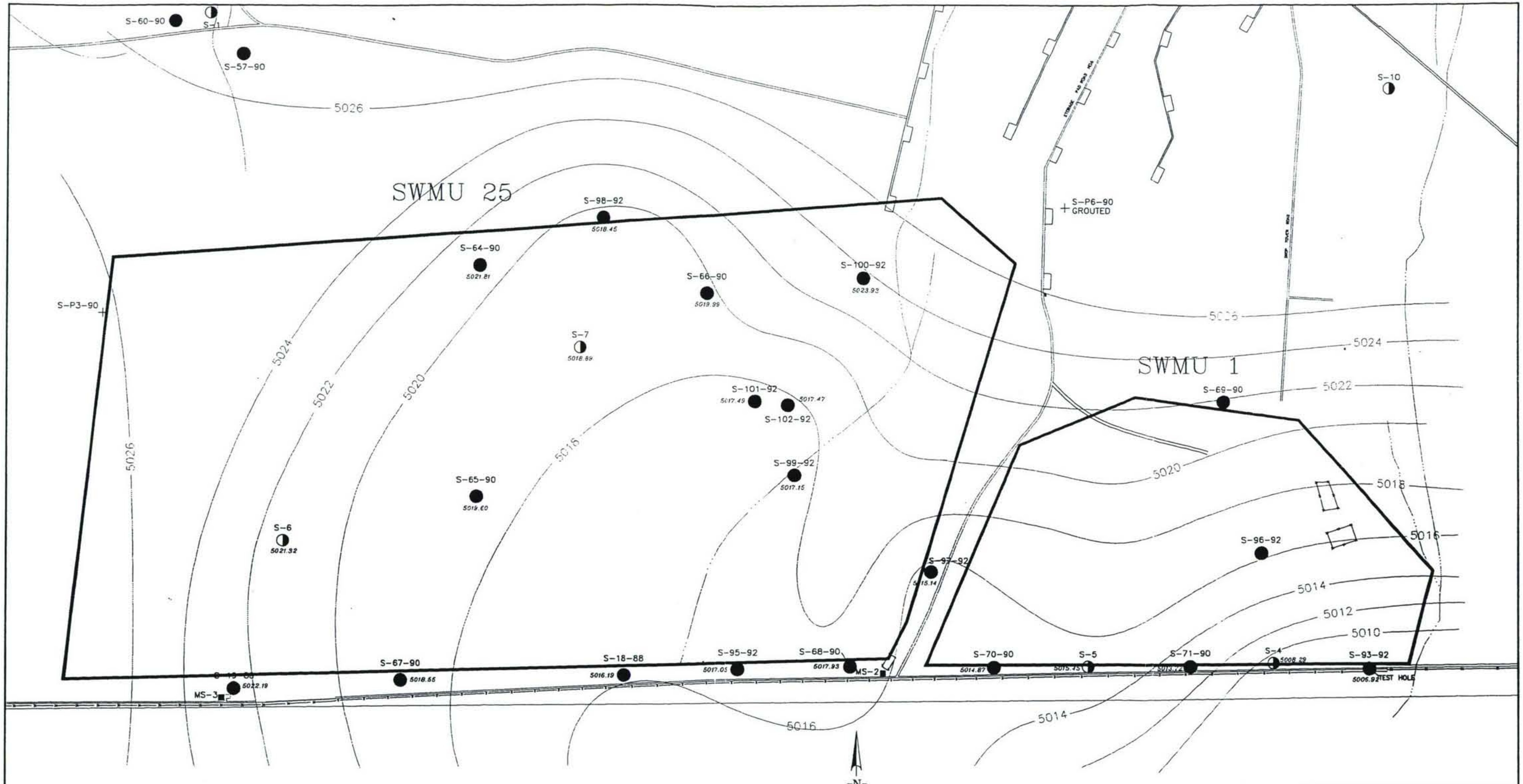
Figure 4.1-15

Depth to Groundwater at SWMU 1 and 25

difficulties, the depth to water and horizontal and vertical hydraulic gradients are discussed only in general terms.

Groundwater flows generally from north to south in SWMUs 1 and 25 (Figures 4.1-16 and 4.1-17). Although groundwater elevations change seasonally from 0 ft to 5 ft, the groundwater flow direction remains relatively constant. The average horizontal hydraulic gradient for this area is 0.0015. The hydraulic gradient in SWMU 1 was calculated along a short flowpath in the vicinity of wells S-71-90 and S-4. No wells are available in SWMU 1 from which a calculation of the hydraulic gradient along longer flowpaths can be made with reasonable confidence, nor are there any well clusters from which vertical gradients can be directly calculated. However, some indications of vertical gradient are suggested. Based on an analysis of the regional flow regime, wells S-69-92 and S-96-92 are located upgradient of the remaining wells in SWMU 1. However, water levels in wells S-69-92 and S-96-92 are lower than water levels in the remaining SWMU 1 wells. One explanation for this is that these wells tap a different water-bearing zone. Water levels in this zone are lower than in the upper water-bearing zone, suggesting a downward gradient in this area. A similar comparison can be made in the southeastern corner of SWMU 25. The screened interval in well S-95-92 is approximately 50 ft lower than the screened interval in well S-68-90, yet water levels in each well are similar. This suggests that vertical gradients in this area are minor. Although there are no adjacent wells for direct comparison, upward gradients are suspected in the central portion of SWMU 25 in the vicinity of wells S-18-88 and S-65-90. Using these assumptions, contaminants in the saturated zone have the potential for downward migration in SWMU 1, but not in SWMU 25. It is also likely that downward gradients at SWMU 1 may reverse direction and have an upward component in the valley bottom located just south of TEAD-S.

Slug tests were conducted in 20 wells (Table 4.1-7) at SWMUs 1 and 25 to estimate the hydraulic conductivity of the water-bearing units in the vicinity of each well. Estimates of hydraulic conductivity were obtained from either a "falling head" test, "rising head" test, or baildown recovery test using analytical methods presented by Bouwer and Rice (1976). Estimates of hydraulic conductivity range from approximately 10^{-5} to 10^{-3} cm/sec. Hydraulic conductivity is highest in the southwest corners of both SWMUs 1 and 25 and at well S-102-92 in the east-central portion of SWMU 25. Lower hydraulic conductivity values were estimated in the eastern half of SWMU 1 and at well S-95-92 in SWMU 25. The five highest estimates of hydraulic conductivity (approximately 10^{-3} cm/sec) were from wells that are less than 75 ft deep. The four lowest estimates of hydraulic conductivity (approximately 10^{-5} cm/sec) are from



LEGEND

5022	Approximate Groundwater Elevation Feb. 1993 in Feet
S-67-90 ●	Ebasco Moniroring Well
S-6 ◐	Ertec Monitoring Well
S-P6-90 +	Ebasco Piezometer
	SWMU Fence Boundary
	Facility Boundary
	Major Access Roads
	Surface Water Drainage

Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 4.1-16

Groundwater Elevations
Febuary 1993

Prepared by:
Ebasco Services Incorporated

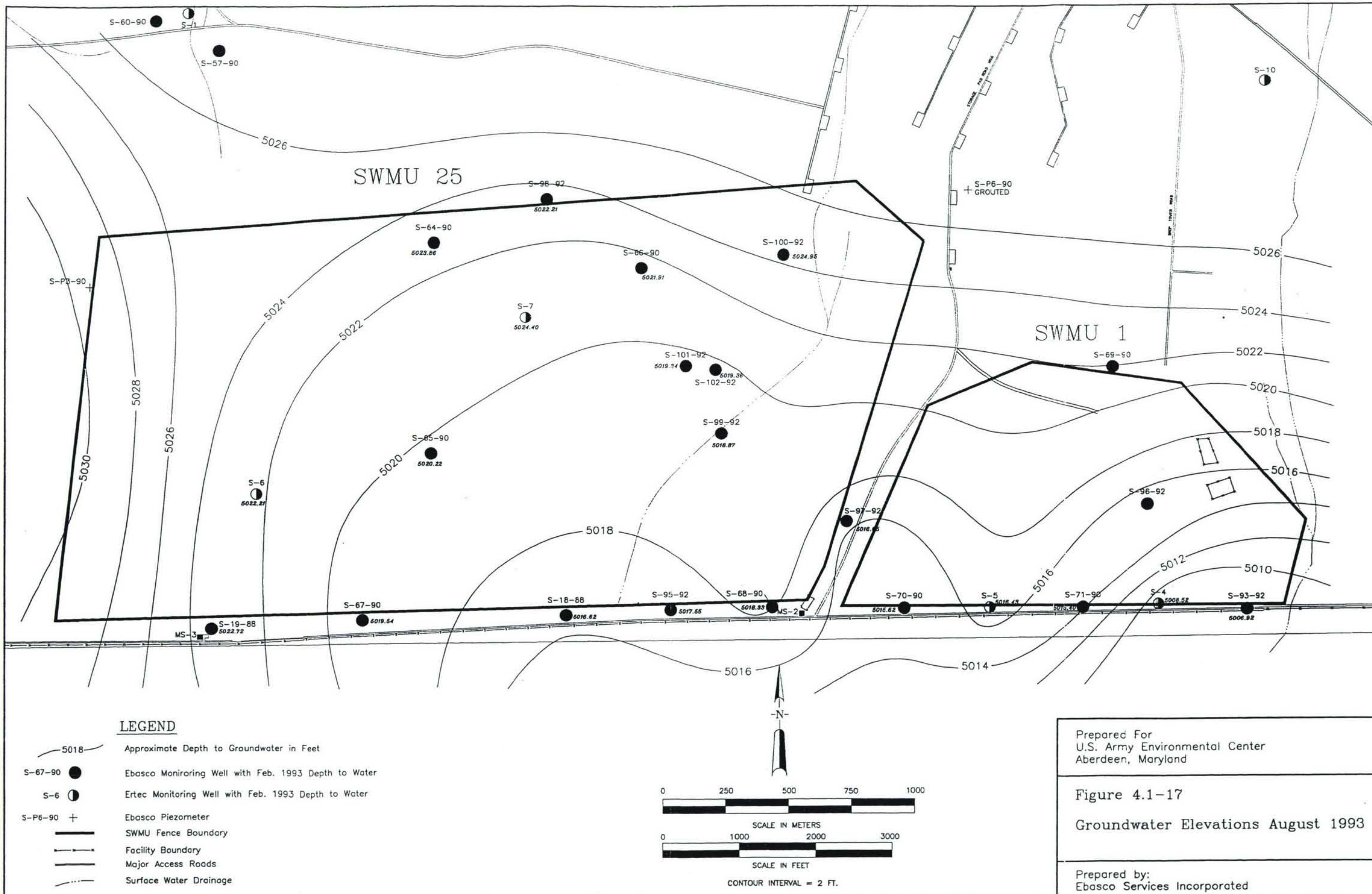


Figure 4.1-17

Groundwater Elevations August 1993

Well	Depth to Water (ft)*	Screened Interval (TOC) (ft)	Sand Pack (TOC) (ft)	Casing (TOC) (ft)	Type of Test	Hydraulic Conductivity (cm/sec)
S-4	58.23	65.64 - 85.64	37.14 - 92.14	65.64	Withdrawal	2.6E-005
S-18-88	21.52	18.5 - 38.5	12.3 - 41.3	18.5	Withdrawal	1.5E-004
S-19-88	31.71	16.32 - 36.32	8.92 - 36.32	16.32	Baildown/Recovery	6.1E-003
S-64-90	23.66	27.0 - 37.0	16.0 - 37.5	27.0	Withdrawal	1.8E-004
S-65-90	18.61	17.5 - 27.5	12.5 - 30.5	17.5	Withdrawal	1.8E-004
S-66-90	38.91	86.5 - 96.5	80.5 - 96.5	86.5	Withdrawal	1.2E-004
S-67-90	20.33	28.5 - 38.5	23.5 - 41.5	28.5	Withdrawal	5.2E-003
S-68-90	41.38	55.0 - 65.0	49.5 - 65.0	55.0	Withdrawal	2.2E-004
S-69-90	102.98	115.2 - 125.2	109.1 - 125.2	115.2	Withdrawal	2.7E-005
S-70-90	46.16	42.5 - 52.5	36.5 - 52.5	42.5	Withdrawal	9.4E-004
S-71-90	42.44	60.5 - 70.5	52.5 - 70.5	60.5	Withdrawal	9.9E-006
S-93-92	66.07	138.5 - 153.5	130.5 - 154.0	138.5	Withdrawal	4.2E-005
S-95-92	25.82	104.8 - 130.3	99.3 - 133.3	104.8	Injection	3.8E-005
S-96-92	69.26	101.9 - 116.9	96.9 - 117.3	101.9	Injection	7.1E-005
S-97-92	71.21	75.0 - 85.0	67.5 - 86.0	75.0	Withdrawal	8.6E-005
S-98-92	30.36	31.2 - 41.2	25.8 - 43.5	31.2	Withdrawal	1.5E-004
S-99-92	31.86	30.3 - 40.3	25.3 - 42.3	30.3	Withdrawal	2.1E-004
S-100-92	53.05	61.8 - 76.8	56.3 - 77.2	61.8	Withdrawal	1.2E-005
S-101-92	41.97	42.4 - 52.4	36.4 - 54.4	42.4	Withdrawal	1.5E-004
S-102-92	36.43	36.0 - 46.0	30.5 - 46.5	36.0	Withdrawal	3.5E-003

Note: All values in feet
* Measurement taken prior to slug test

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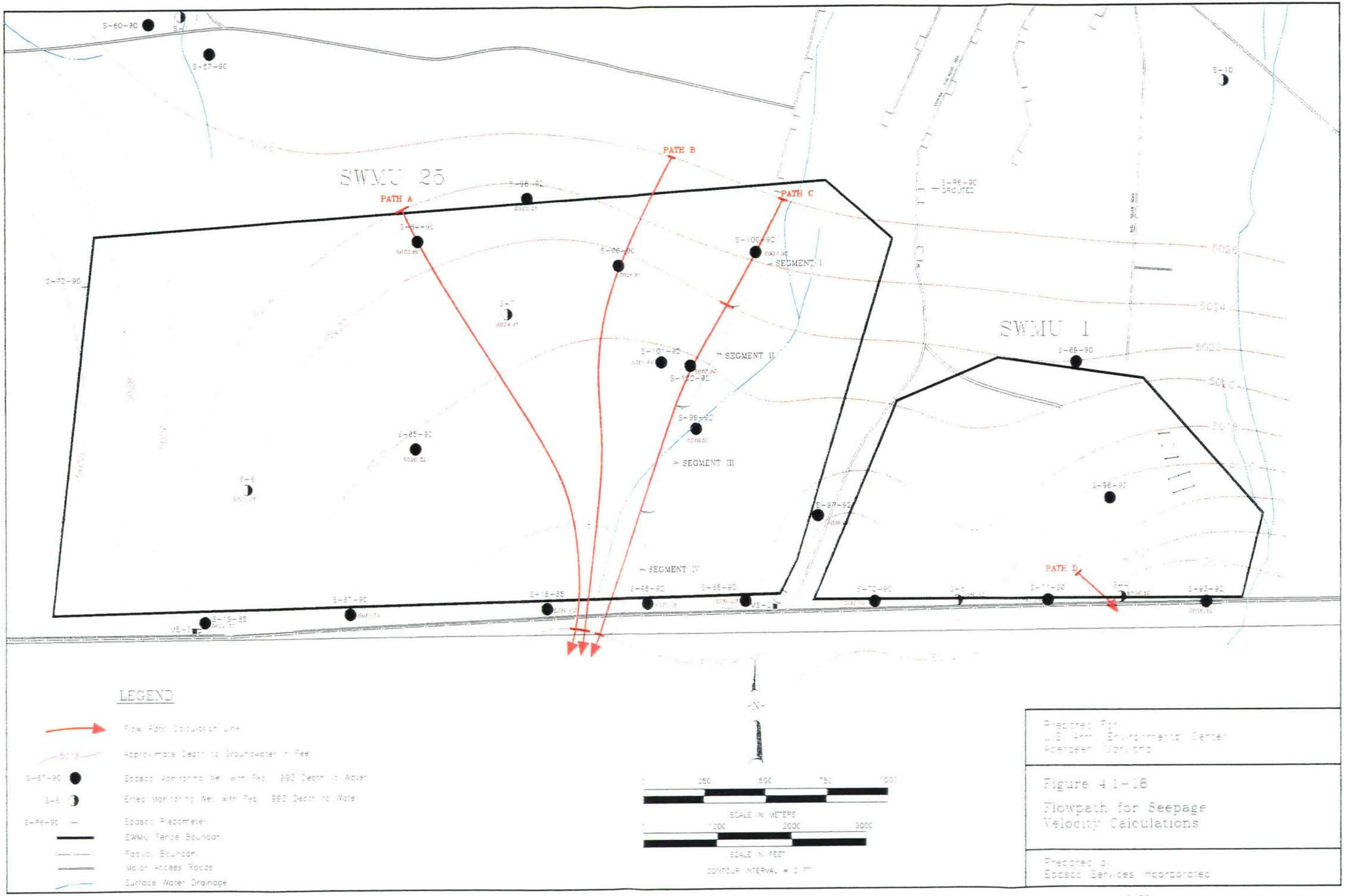
wells that are more than 100 ft deep. These values are within the expected range for clay, silt, and silty fine-grained sand units such as are present in this area (Freeze and Cherry 1979).

Seepage velocities were calculated along several flowpaths in SWMUs 1 and 25 (Figure 4.1-18). Seepage velocity is the average velocity at which groundwater flows under a given gradient and aquifer permeability. Using an average hydraulic conductivity of 0.41 ft per day, a hydraulic gradient of 0.0013 and assumed effective porosity values of 2 and 10 percent, the travel time along the 6,200-ft-long flowpath A ranges from approximately 600 to 3,000 years. Travel time along flowpath B also ranges from approximately 600 to 3,000 years, assuming a hydraulic conductivity of 0.40 ft per day, a hydraulic gradient of 0.0015, effective porosities of 2 and 10 percent, and a flowpath of 6,600 ft.

Because more wells are located close to flowpath C, it was divided into four segments, each segment having its own hydraulic conductivity, hydraulic gradient, length, and effective porosity. Along flowpath C the fastest flow appears to occur near well S-102-92, where seepage velocities range from 35 to 350 ft per year, using effective porosities of 2 to 20 percent. Seepage velocities along the remaining segments of flowpath C range from less than 1 ft per year to approximately 6 ft per year. Using these seepage velocities, travel time along flowpath C ranges from approximately 2,000 to 10,000 years. If it is assumed that an effective porosity of 2 percent is reasonable for these clayey and silty sediments, then a travel time of approximately 2,000 years is likely along the entire flow path of 6,400 ft.

Due to the lack of water-level information in SWMU 1, only one flowpath was evaluated. Assuming hydraulic conductivity of 0.051 ft per day, a hydraulic gradient of 0.008, and effective porosities of 2 and 10 percent, the seepage velocity along flowpath D ranges from 1.5 to 7.5 ft per year. Using these estimates, the travel times along the 500-ft-long flowpath D are 67 to 340 years, respectively.

The off-post Stookey well is located approximately 1,500 feet south of SWMU 25 well S-95-92. There are no off-post wells directly along this flowpath from which a gradient can be determined. Therefore, a hydraulic gradient of 0.00125 from segment IV of flowpath C and a hydraulic conductivity of 0.6 ft per day from well S-68-90 were used to calculate travel times from the southern boundary of SWMU 25 to the Stookey well. These travel times range from approximately 100 to 500 years.


SWMU 25
SWMU 1
PATH A
PATH B
PATH C
PATH D
SEGMENT I
SEGMENT II
SEGMENT III
SEGMENT IV
S-60-90
S-57-90
S-64-90
S-06-90
S-100-90
S-101-90
S-102-90
S-99-90
S-25-90
S-97-90
S-96-90
S-69-90
S-86-90 GROUTED
S-87-90
S-18-85
S-10
S-6
5026
5024
5022
LEGEND
-N-
SCALE IN METERS
SCALE IN FEET
CONTOUR INTERVAL = 2 FT
Figure 4.1-18
Flowpath for Seepage Velocity Calculations
Prepared by
Ebasco Services Incorporated

4.1.1.4 Demography and Land and Water Use

No land development has occurred outside of the south TEAD-S boundary near SWMUs 1 and 25. The immediate area on site surrounding the SWMUs is also undeveloped except for two roads, one separating the two SWMUs and one along their southern boundary, and one meteorological monitoring building located between the two SWMUs at the intersection of these two roads. About 3,500 ft to the northwest of SWMU 25 is the CAMDS facility, an area of industrial buildings which operate daily. About 1,500 ft north of SWMU 25 is an east-west evacuation road which leads to the CAMDS facility.

The nearest community to SWMUs 1 and 25 is the town of Vernon, which has a population of approximately 200 people (1990 Census) and which is approximately 11 mi to the southwest.

The land adjacent to the south boundary of TEAD-S is a mix of public and private lands used as rangeland. Two water diversion points exist within approximately 2,000 ft of the boundary (Figure 2.1-7). Their present use could not be confirmed.

4.1.2 <u>Nature and Extent of Contamination</u>

4.1.2.1 Soil Contamination Assessment

This section presents the chemical analytical results of the soil sampling program at SWMUs 1 and 25. The samples, results, and evaluations are grouped according to SWMU and source area. Figure 4.1-19 shows the spatial relationships of the sample locations in the source areas. Sample locations were generally selected because of visible evidence of contamination or proximity to debris or man-made features.

Although this section presents all of the analytical data collected in the RFI-Phase II, it focuses on the results for COCs that are being considered by the risk assessment. The metal COCs are aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), cyanide (Cyn), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), thallium (Tl), and zinc (Zn).

<u>Previous Investigations</u>

In 1982, two sediment samples were collected from a ditch along the southern border of SWMU 1. These two sediment samples were taken from 0 to 6 inches below the ground surface ~~to assess the possibility of contaminant transport by runoff. The samples were analyzed for SVOCs, explosives, metals, anions, and radiological parameters (gross alpha and gross beta).~~

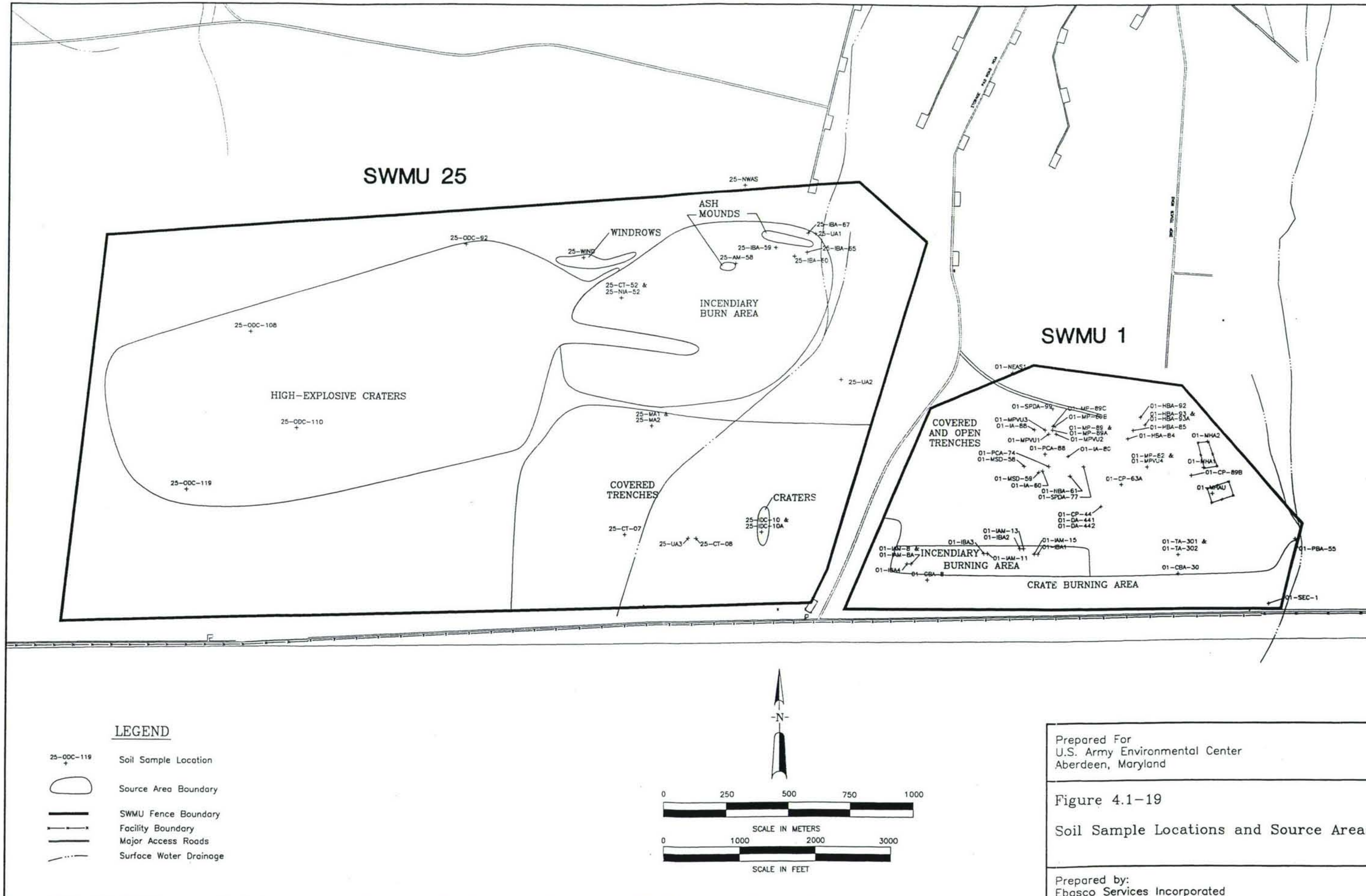


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Figure 4.1-19

Soil Sample Locations and Source Areas

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to assess the possibility of contaminant transport by runoff. The samples were analyzed for SVOCs, explosives, metals, anions, and radiological parameters (gross alpha and gross beta). Several inorganic analytes were detected in both samples. Sediment sample S-SD-1, collected near the southeastern corner of SWMU 1, contained phosphate, sulfate, and nitrate, while sediment sample S-SD-2, collected near the south-central boundary of SWMU 1, contained chloride, sodium, sulfate, nitrate, and nickel. The detected nickel concentration was below background. Only sodium and nitrate were detected at concentrations greater than background. Background data are available only for samples collected at CAMDS (known releases Unit 13). No sediment or soil sampling was performed at SWMU 1 during the RFI-Phase I.

In 1988, two soil samples were collected south of SWMU 25 along the southern boundary of the installation. These samples were analyzed for explosives, metals, anions, and radionuclides. All results were at or below background.

Concurrent with the RFI-Phase I, the TEAD Ammunition Equipment Directorate (TEAD-AED) collected samples of demilitarized residue at the SWMU 25 windrows and slag piles to determine whether it was hazardous waste. These samples were collected from the top, middle, and bottom of each waste pile and analyzed for extraction procedure (EP) toxicity, explosives, and solvents. None of the samples revealed either EP toxicity or explosive compounds, but low concentrations of solvents were detected in two of six samples from the windrows, as well as in samples from the slag piles. The results of previous sampling at TEAD-S can be found in Appendix E.

RFI-Phase II Results

The distribution of soil contamination in RFI-Phase II samples is illustrated in Figures 4.1-20 through 4.1-38. Figure 4.1-20 presents the results of all VOCs, SVOCs, explosives, and ABPs. Figures 4.1-21 through 4.1-38 present the concentrations of each metal in alphabetical order. All detections are presented in Table 4.1-8. The complete chemical data can be found in Appendix F1.

In SWMU 1, all soil samples collected were surficial samples collected from a depth of 0 to 2 inches (0.1 ft). Samples from SWMU 25 included mostly surficial and some subsurface soil from areas like the high-explosive craters, windrows, ash mounds, and incendiary burn area, where agent contamination is not expected. Subsurface sample depths are listed next to any detected analyte concentration on the figures. Samples were collected from a wide variety of disposal features (e.g., covered trenches, near discarded or burned debris) within each SWMU.

Several inorganic analytes were detected in both samples. Sediment sample S-SD-1, collected near the southeastern corner of SWMU 1, contained phosphate, sulfate, and nitrate, while sediment sample S-SD-2, collected near the south-central boundary of SWMU 1, contained chloride, sodium, sulfate, nitrate, and nickel. As no data have been collected to evaluate background concentrations of these anions, it is unknown whether these detections indicate contamination. The detected nickel concentration was below background. No sediment or soil sampling was performed at SWMU 1 during the RFI-Phase I.

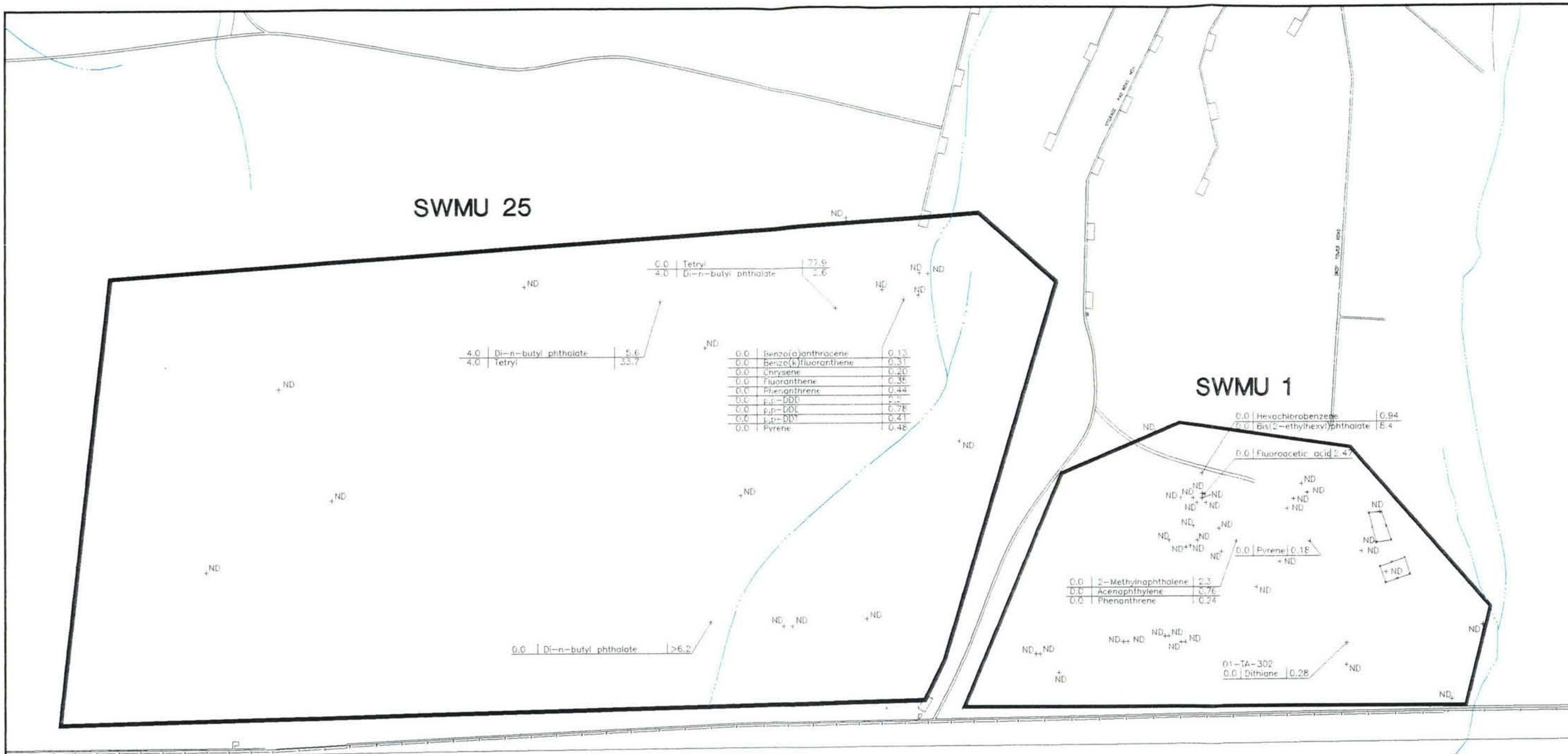
In 1988, two soil samples were collected south of SWMU 25 along the southern boundary of the installation. These samples were analyzed for explosives, metals, anions, and radionuclides. All results were at or below background.

Concurrent with the RFI-Phase I, the TEAD Ammunition Equipment Directorate (TEAD-AED) collected samples of demilitarized residue at the SWMU 25 windrows and slag piles to determine whether it was hazardous waste. These samples were collected from the top, middle, and bottom of each waste pile and analyzed for extraction procedure (EP) toxicity, explosives, and solvents. None of the samples revealed either EP toxicity or explosive compounds, but low concentrations of solvents were detected in two of six samples from the windrows, as well as in samples from the slag piles. The results of previous sampling at TEAD-S can be found in Appendix E.

<u>RFI-Phase II Results</u>

The distribution of soil contamination in RFI-Phase II samples is illustrated in Figures 0 through 4.1-38. Figure 4.1-20 presents the results of all VOCs, SVOCs, explosives, and ABPs. Figures 1 through 4.1-38 present the concentrations of each metal in alphabetical order. All detections are presented in Table 4.1-8. The complete chemical data can be found in Appendix F1.

In SWMU 1, all soil samples collected were surficial samples collected from a depth of 0 to 2 inches (0.1 ft). Samples from SWMU 25 included mostly surficial and some subsurface soil from areas like the high-explosive craters, windrows, ash mounds, and incendiary burn area, where agent contamination is not expected. Subsurface sample depths are listed next to any detected analyte concentration on the figures. Samples were collected from a wide variety of disposal features (e.g., covered trenches, near discarded or burned debris) within each SWMU.



Analyte

Depth 0.0 | Dithiane | 0.28 Concentrration in micrograms per gram (ug/g)

ND - Analytes were not detected

\+ Soil Sample Location

Notes:
1. For soil location designations see Figure 4.1-7.
2. All depths are given as feet
3. Please see Chemical Acronym List for Acronym definitions.
4. Chemicals of concern are shown in magenta. Others detections above background are shown in black..

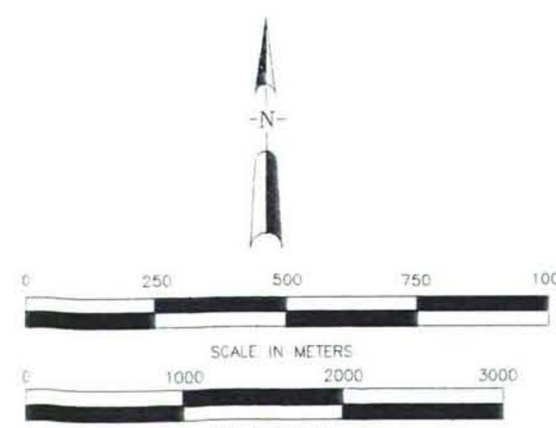


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Figure 4.1-20

Organic Compounds Detected in Soils at SWMUs 1 and 25

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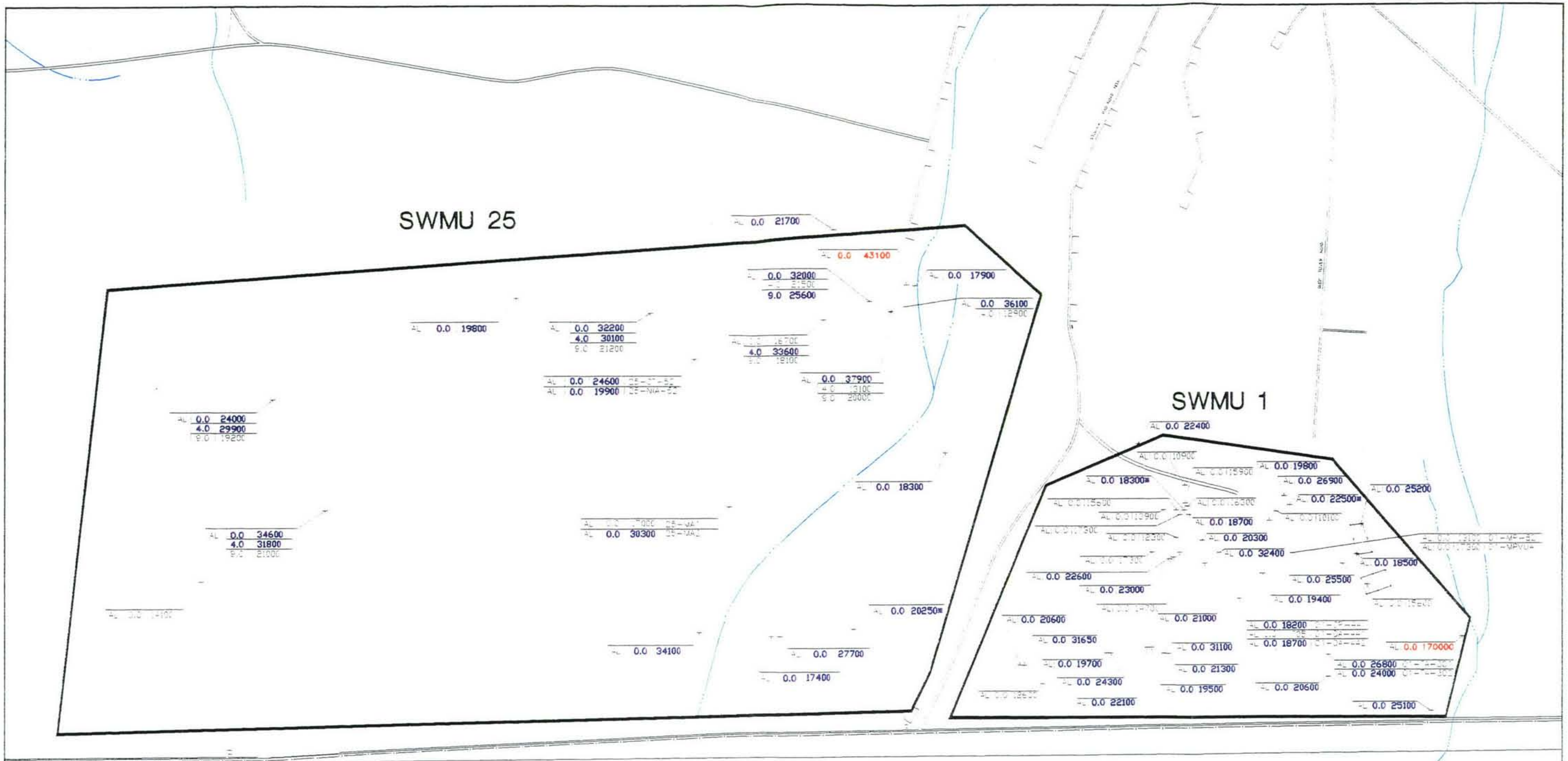

-N-

SCALE IN METERS

0 250 500 750 1000

SCALE IN FEET

0 1000 2000 3000

LEGEND

- Surface Water Drainage
- Soil Sample Location
- SWMU Fence Boundary
- Fence Line
- Major Access Roads

Test Name Depth Concentration

If more than one sample location is near a sample site the site ID number appears after the concentration

ND = Not Detected

5300.0 Highest value above background in each SWMU

27.5 Values above background
Surface background 7,700 mg/g
Subsurface background 25,200 mg/g

Below Background Sample Detection in ug/g

* Concentration shown is average of investigative and duplicate samples

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Figure 4.1-21

Aluminum in Soil at SWMUs 1 and 25

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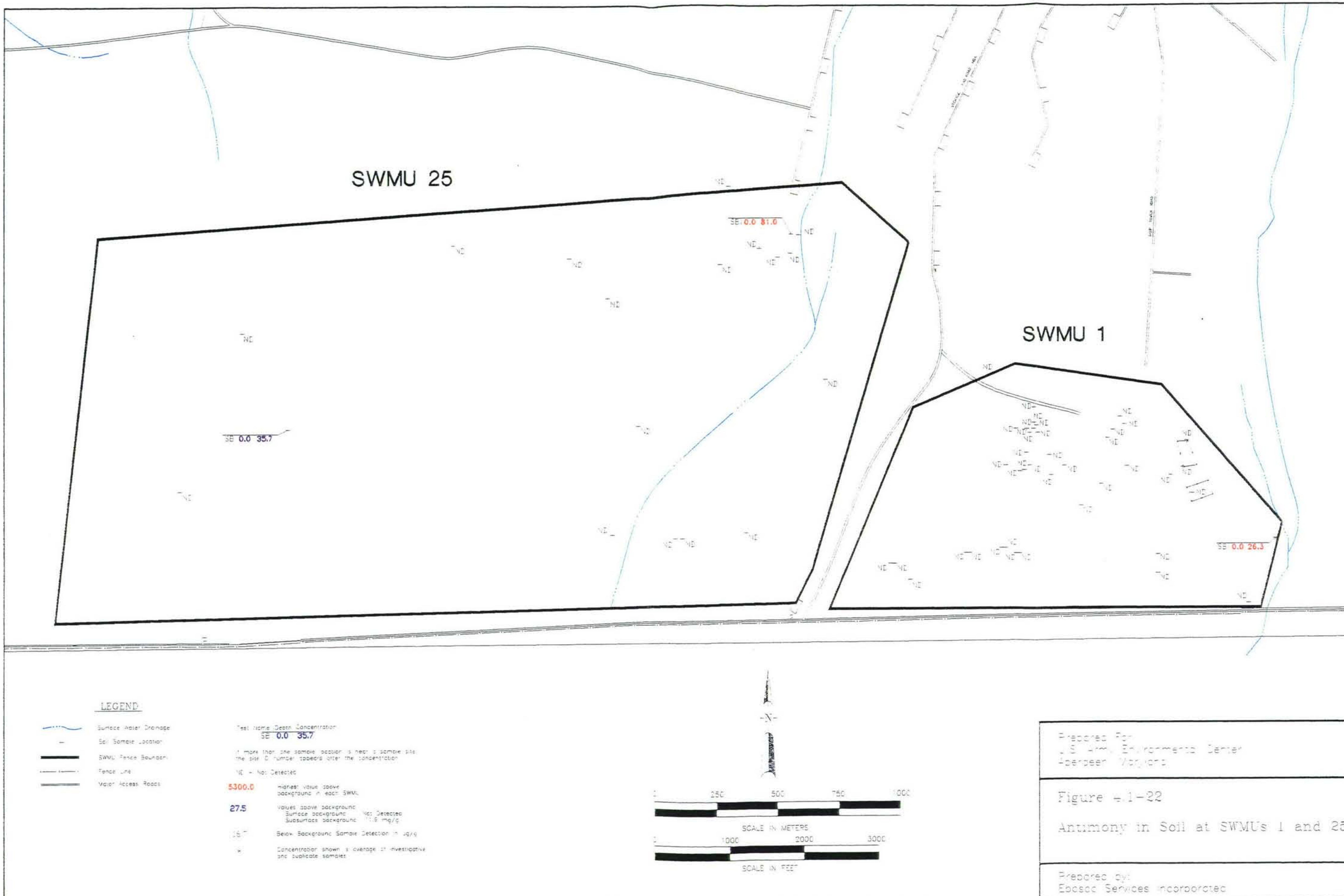

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Figure 4.1-22

Antimony in Soil at SWMUs 1 and 25

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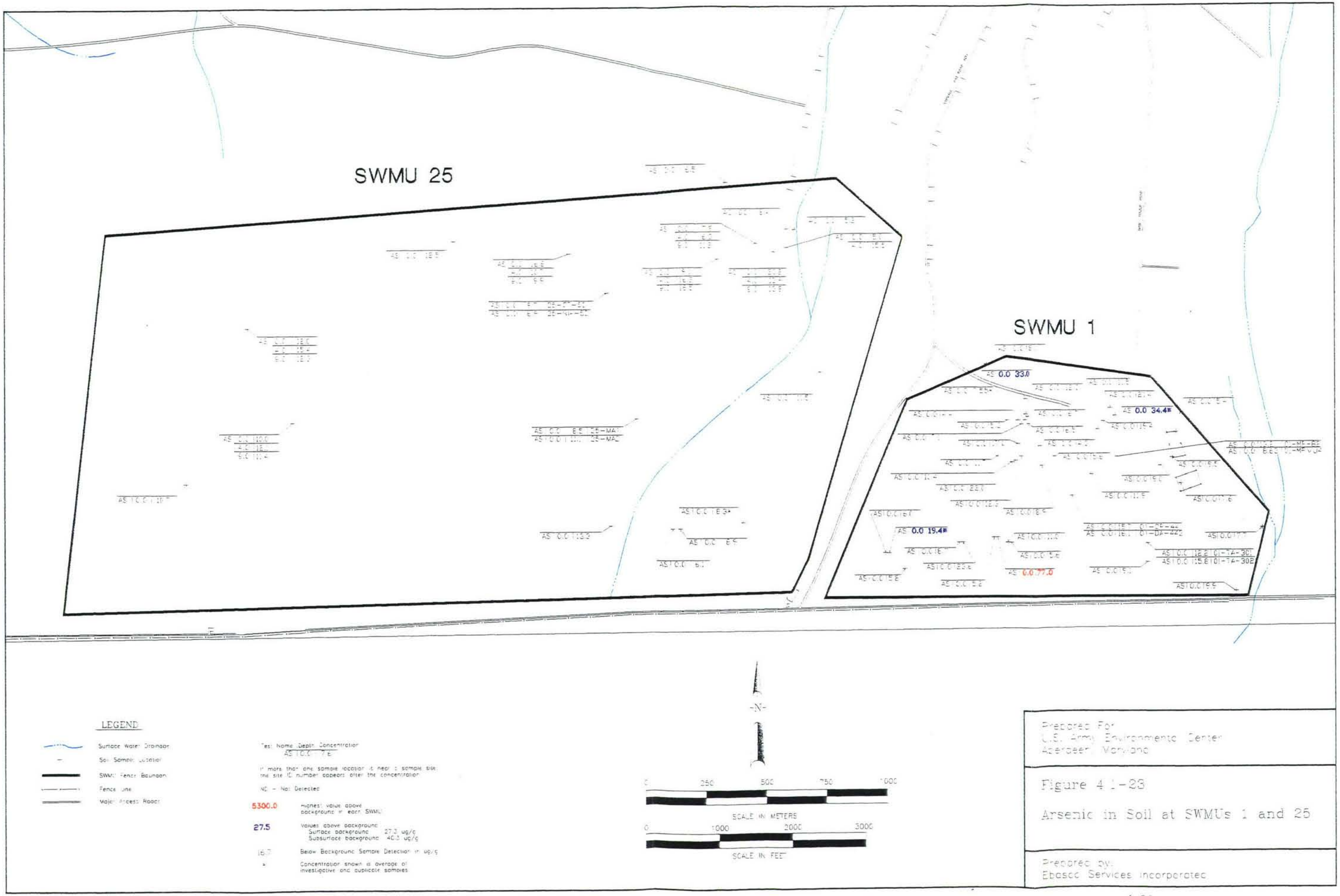
SWMU 25
SWMU 1
AS 0.0 33.0
AS 0.0 34.4
AS 0.0 19.4
AS 0.0 77.0
LEGEND
Surface Water Drainage
Soil Sample Location
SWMU Fence Boundary
Fence Line
Major Access Road
-N-
SCALE IN METERS
SCALE IN FEET
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Figure 4.1-23
Arsenic in Soil at SWMUs 1 and 25
Prepared by:
Ebasco Services Incorporated

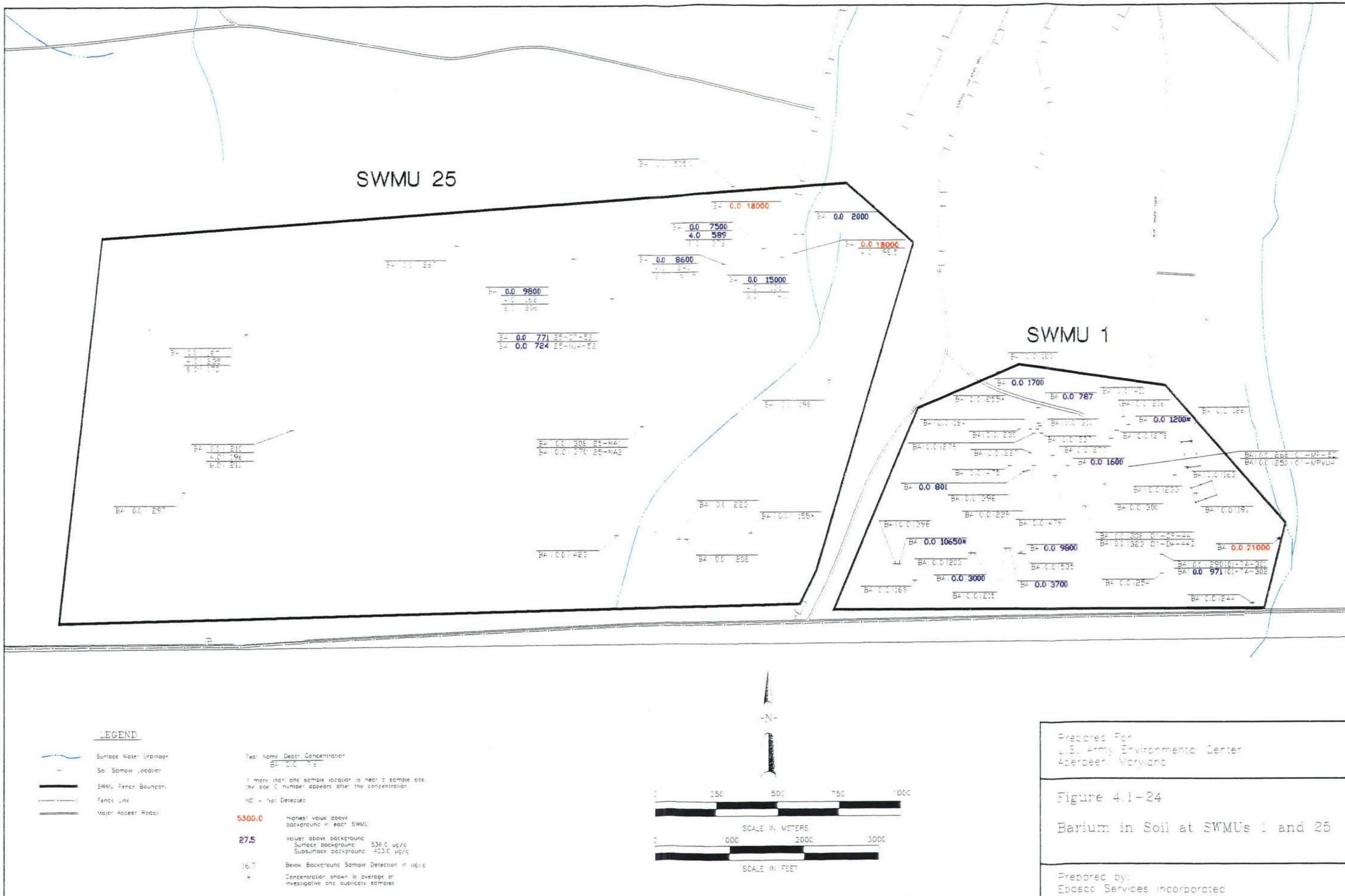

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Figure 4.1-24

Barium in Soil at SWMUs 1 and 25

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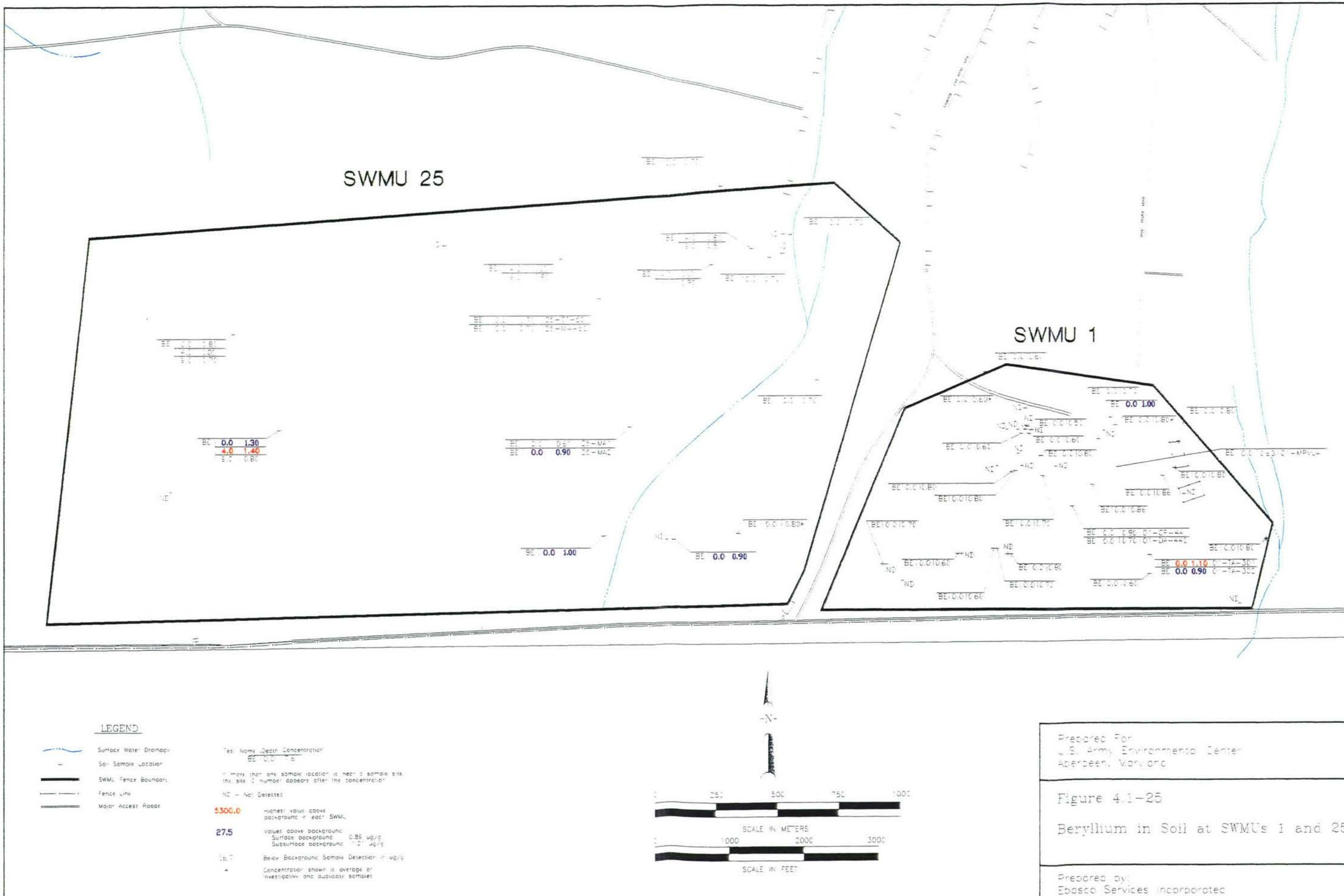

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Figure 4.1-25

Beryllium in Soil at SWMUs 1 and 25

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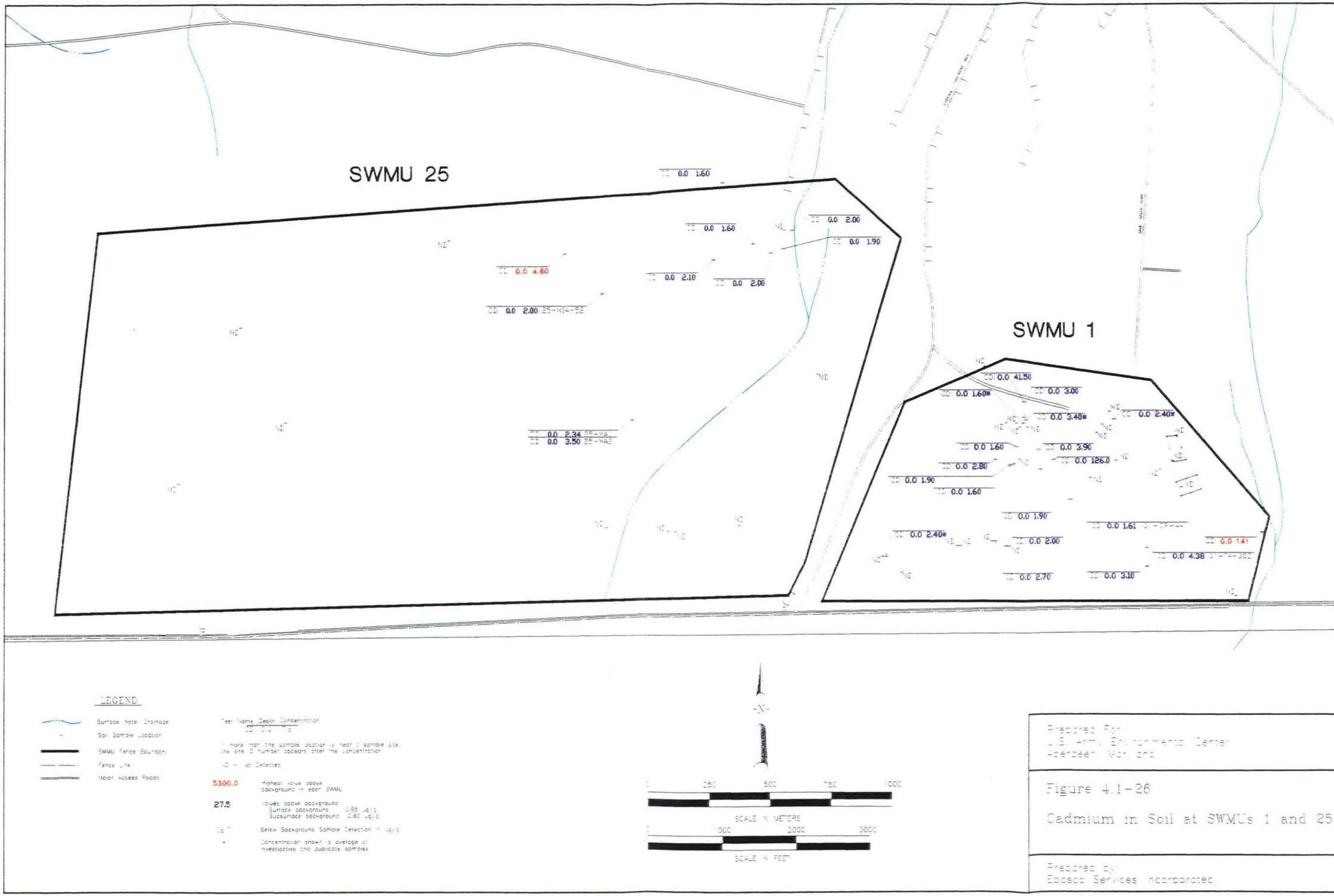

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Figure 4.1-26

Cadmium in Soil at SWMUs 1 and 25

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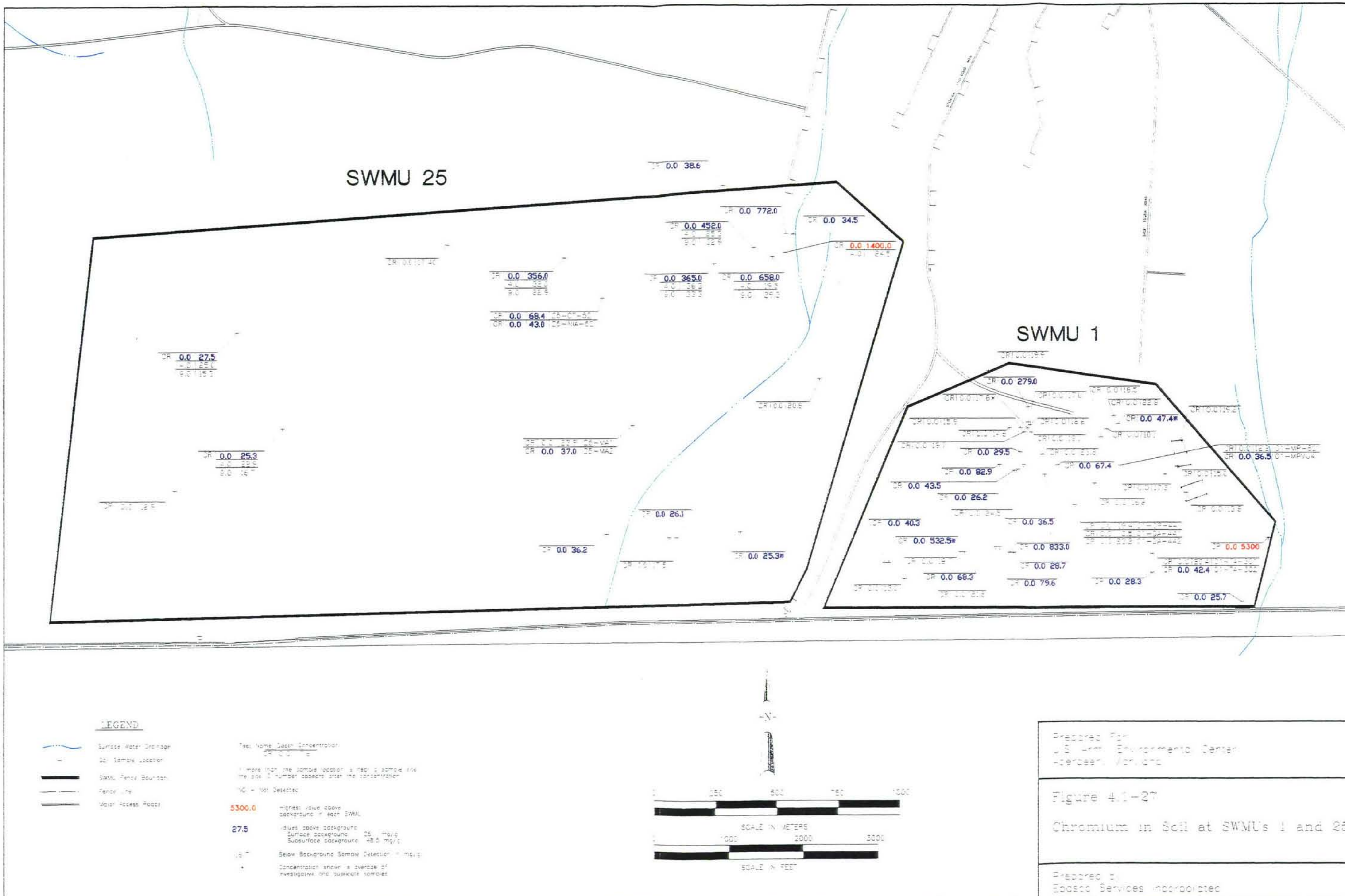

Figure 4.1-27

Chromium in Soil at SWMUs 1 and 25

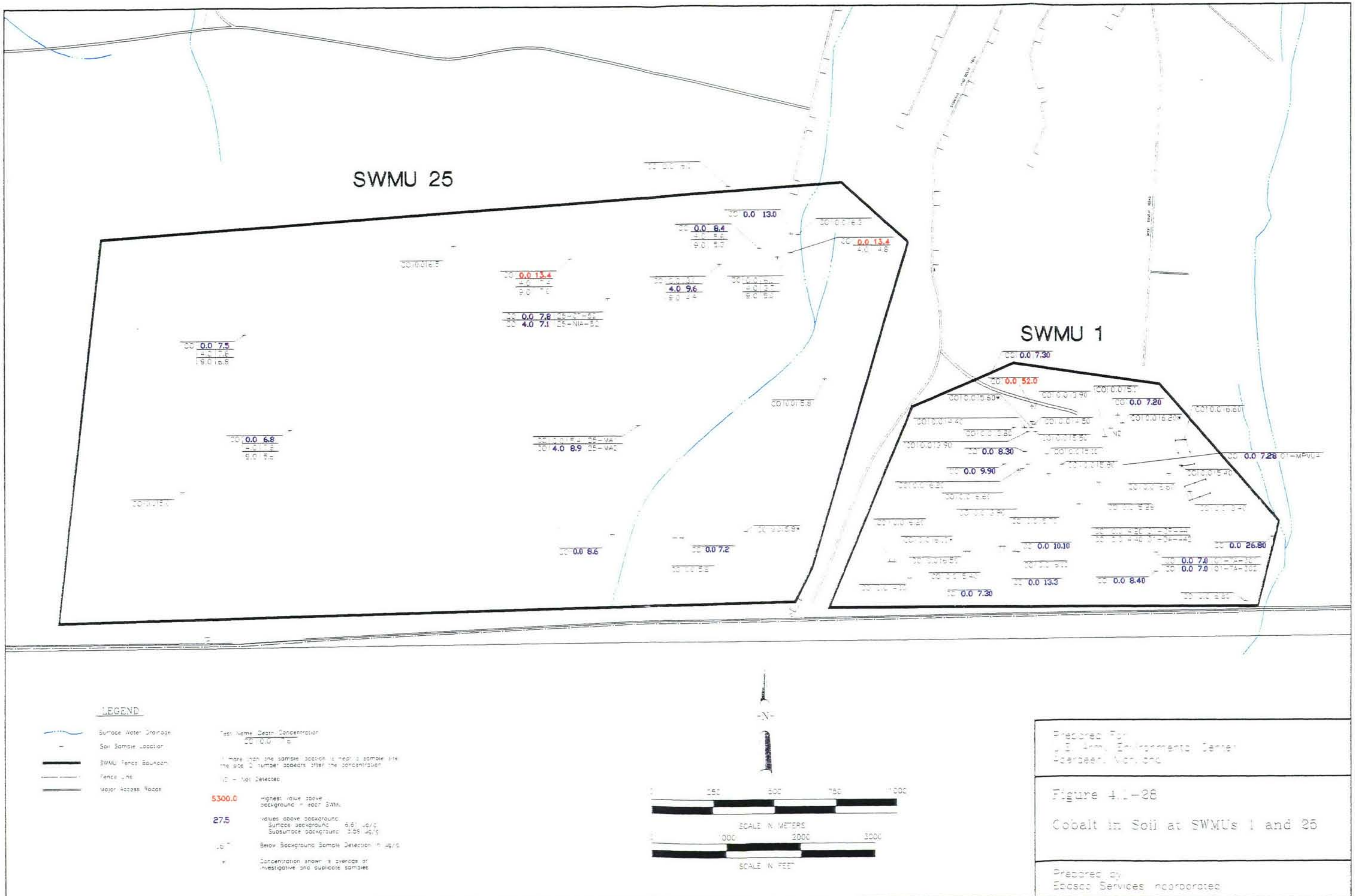

Figure 4.1-28

Cobalt in Soil at SWMUs 1 and 25

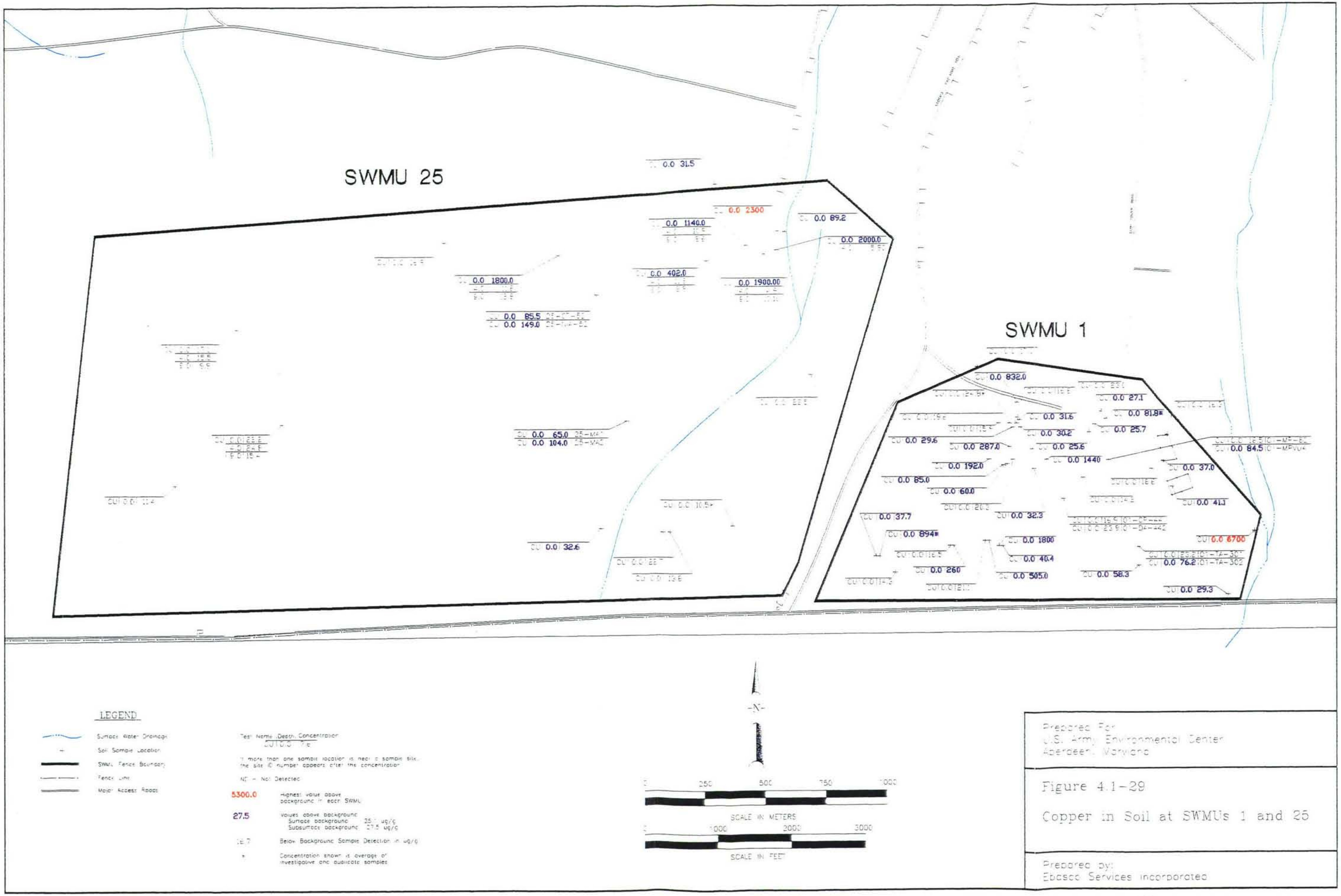

Figure 4.1-29

Copper in Soil at SWMUs 1 and 25

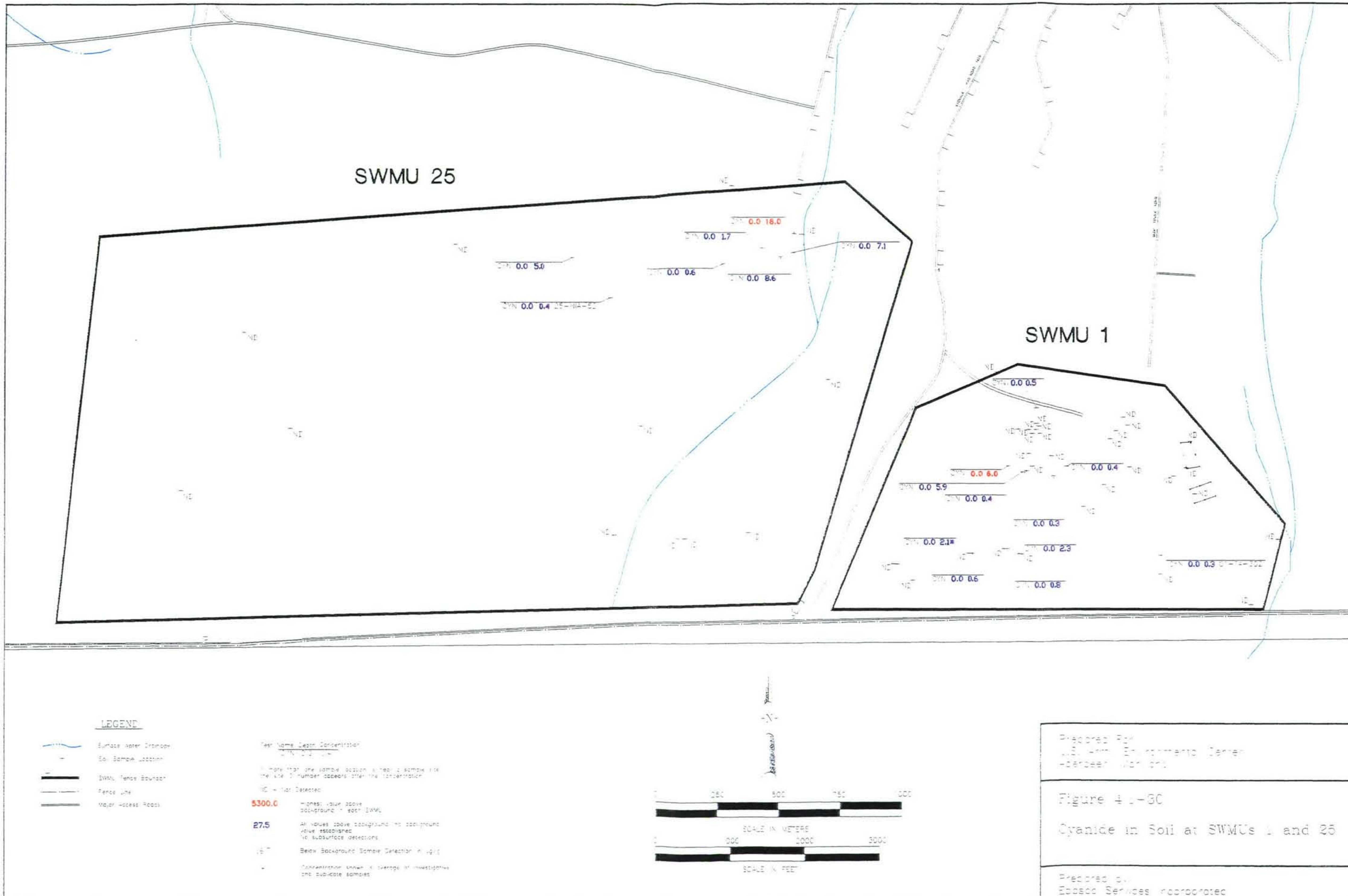

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Figure 4.1-30

Cyanide in Soil at SWMUs 1 and 25

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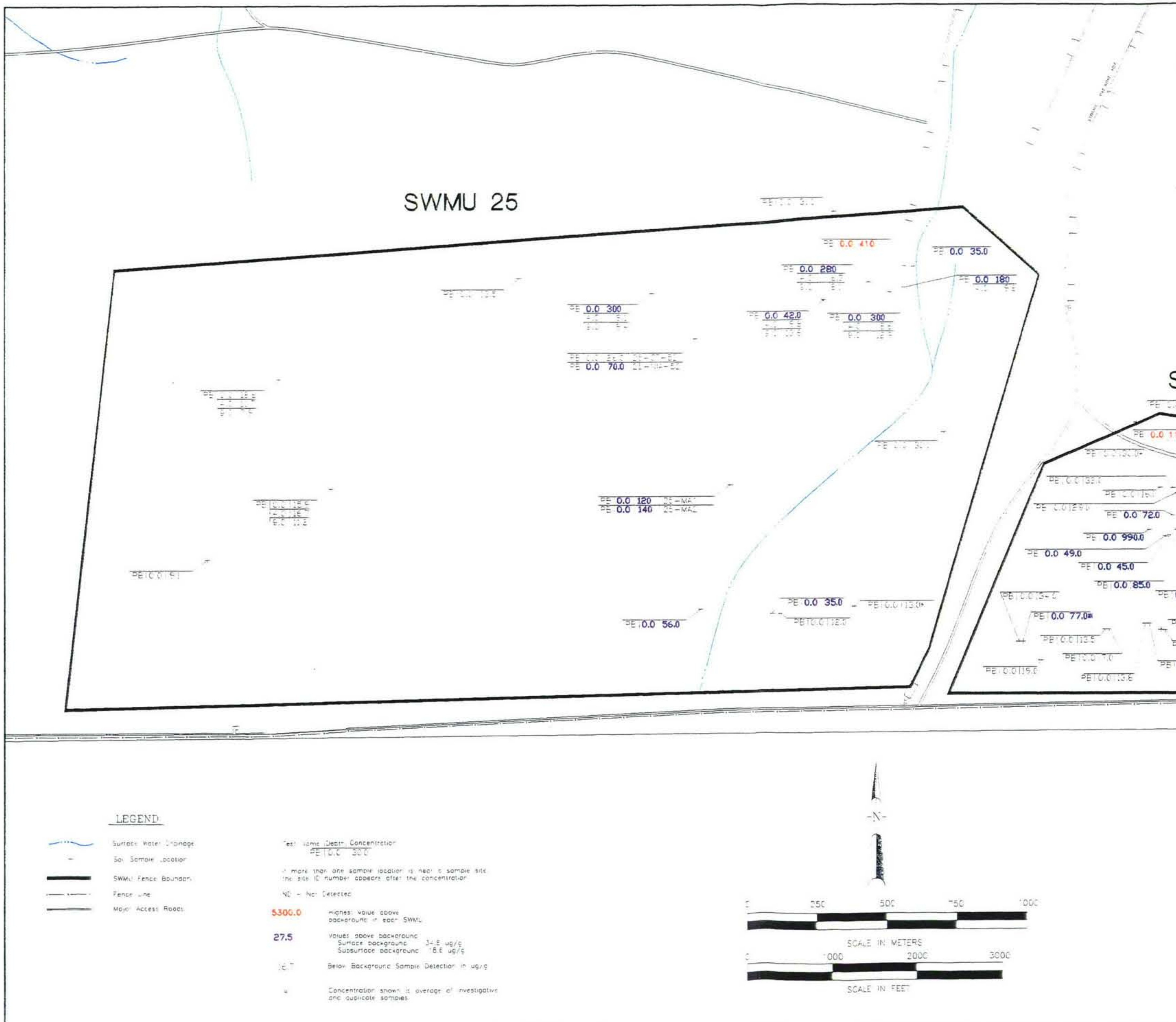

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Figure 4.1-31

Lead in Soil at SWMUs 1 and 25

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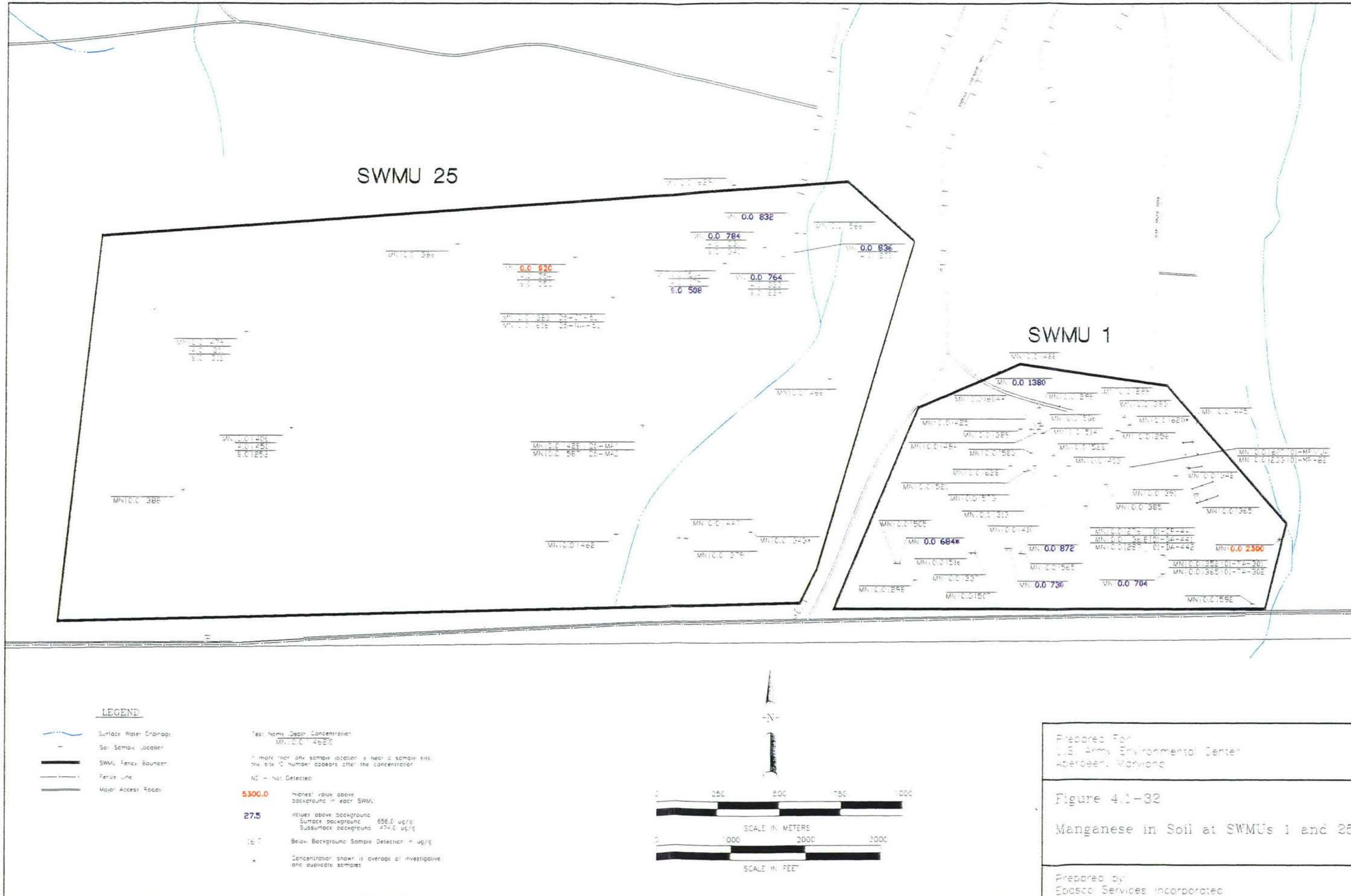
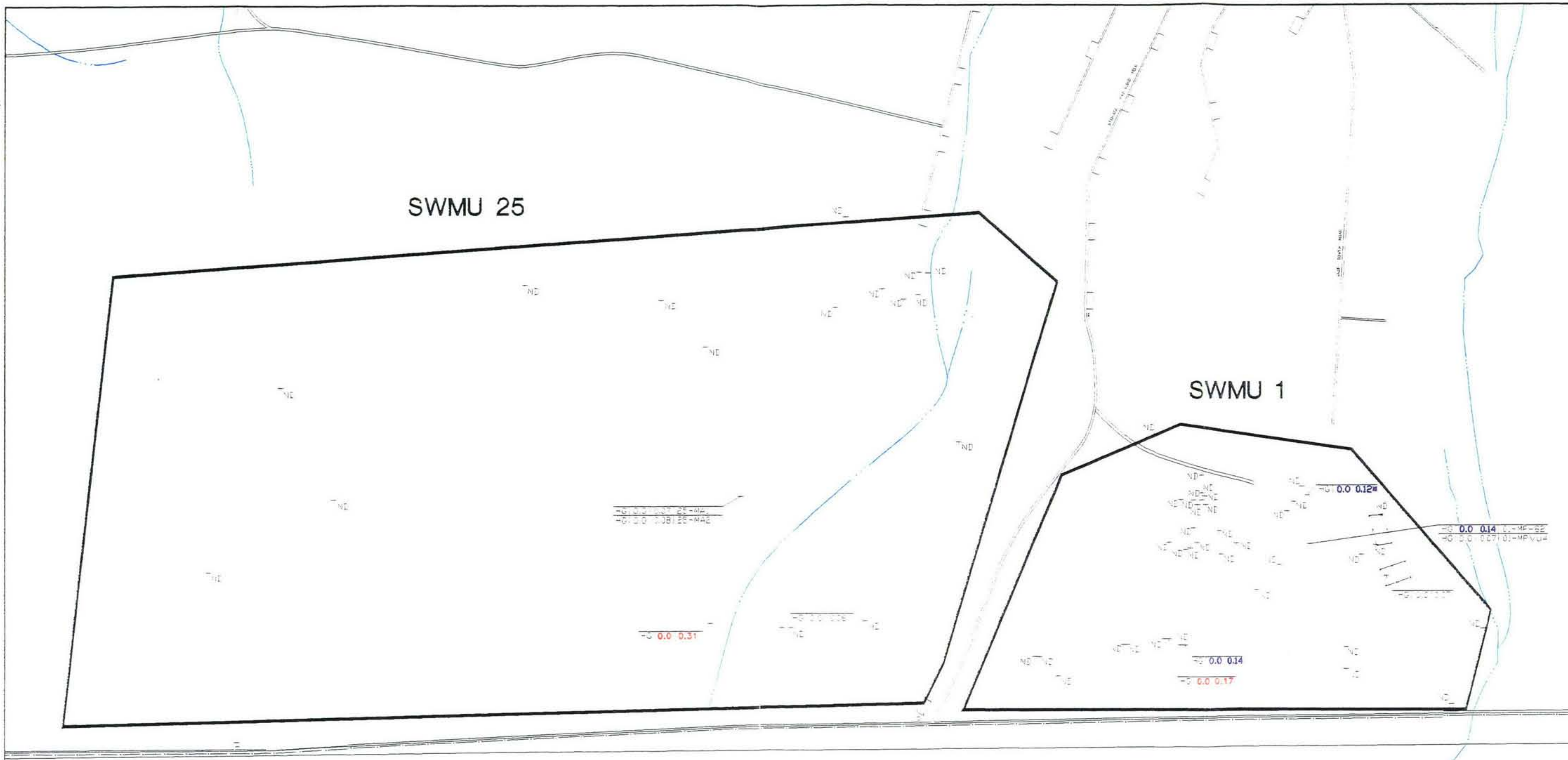
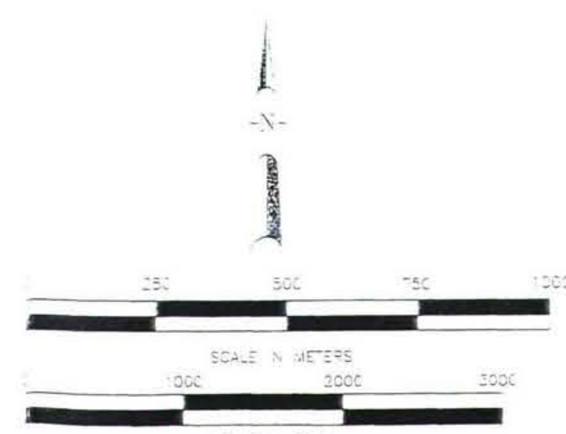


Figure 4.1-32

Manganese in Soil at SWMUs 1 and 25





LEGEND

Surface Water Drainage
Soil Sample Location
SWMU Fence Boundary
Fence Line
Major Access Roads

Test Name Depth Concentration

If more than one sample location is near a sample site the site ID number appears after the concentration

ND = Not Detected

5300.0 Highest value above background in each SWMU

27.5 Values above background
Surface background 0.08 µg/g
Subsurface background 0.14 µg/g

Below Background Sample Detection in µg/g

* Concentration shown is average of investigative and duplicate samples

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Figure 4.1-33

Mercury in Soil at SWMUs 1 and 25

Prepared by:
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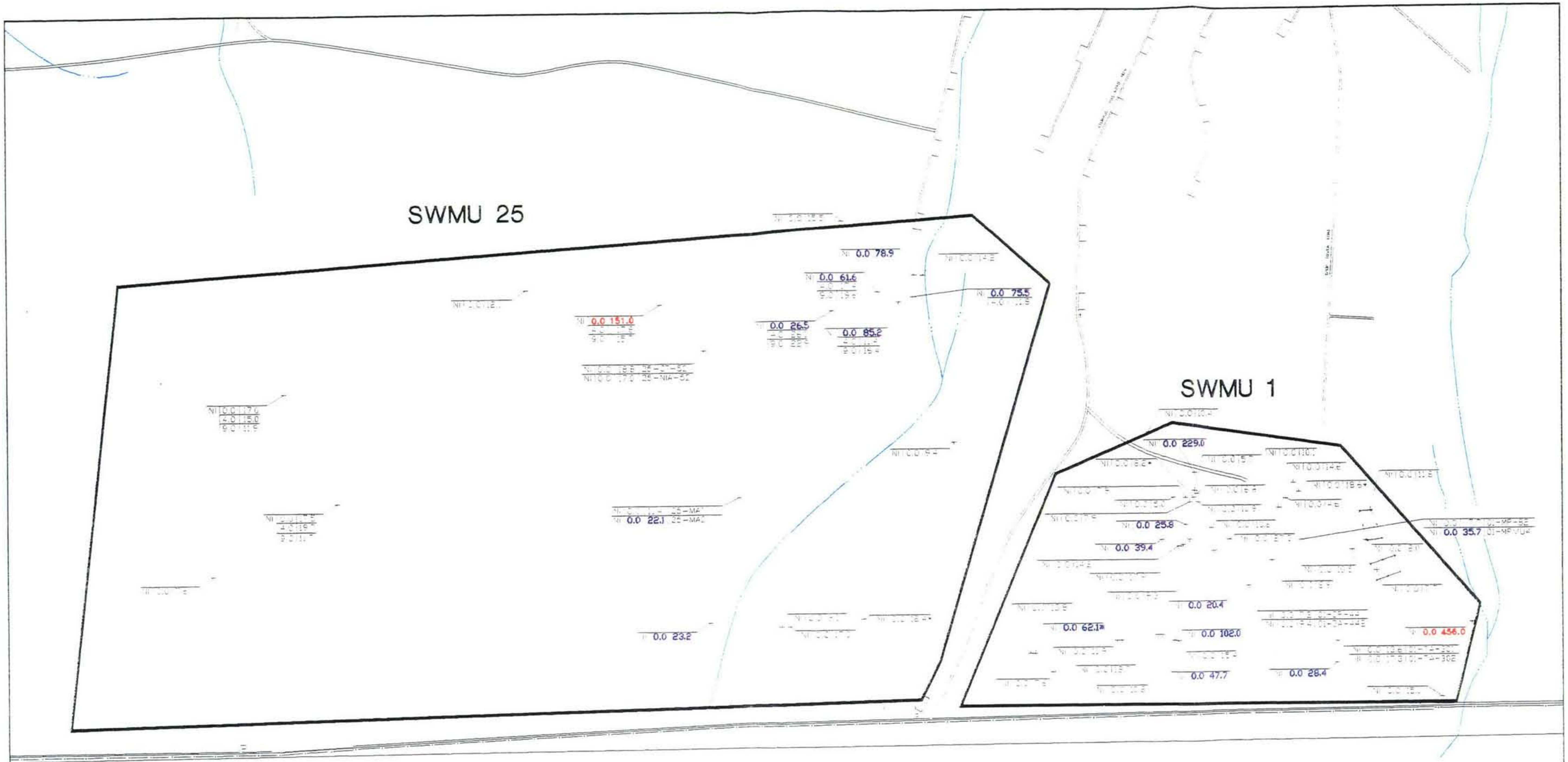

LEGEND

Surface Water Drainage

Soil Sample Location

SWMU Fence Boundary

Fence Line

Major Access Roads

Test Name Depth Concentration

If more than one sample location is near a sample site the site ID number appears after the concentration

ND = Not Detected

5300.0 — Highest value above background in each SWMU

27.5 — Values above background
Surface background 19.5 ug/g
Subsurface background [illegible] ug/g

Below Background Sample Detection in ug/g

* — Concentration shown is average of investigative and duplicate samples

0 250 500 750 1000
SCALE IN METERS

0 1000 2000 3000
SCALE IN FEET

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Figure 4.1-34

Nickel in Soil at SWMUs 1 and 25

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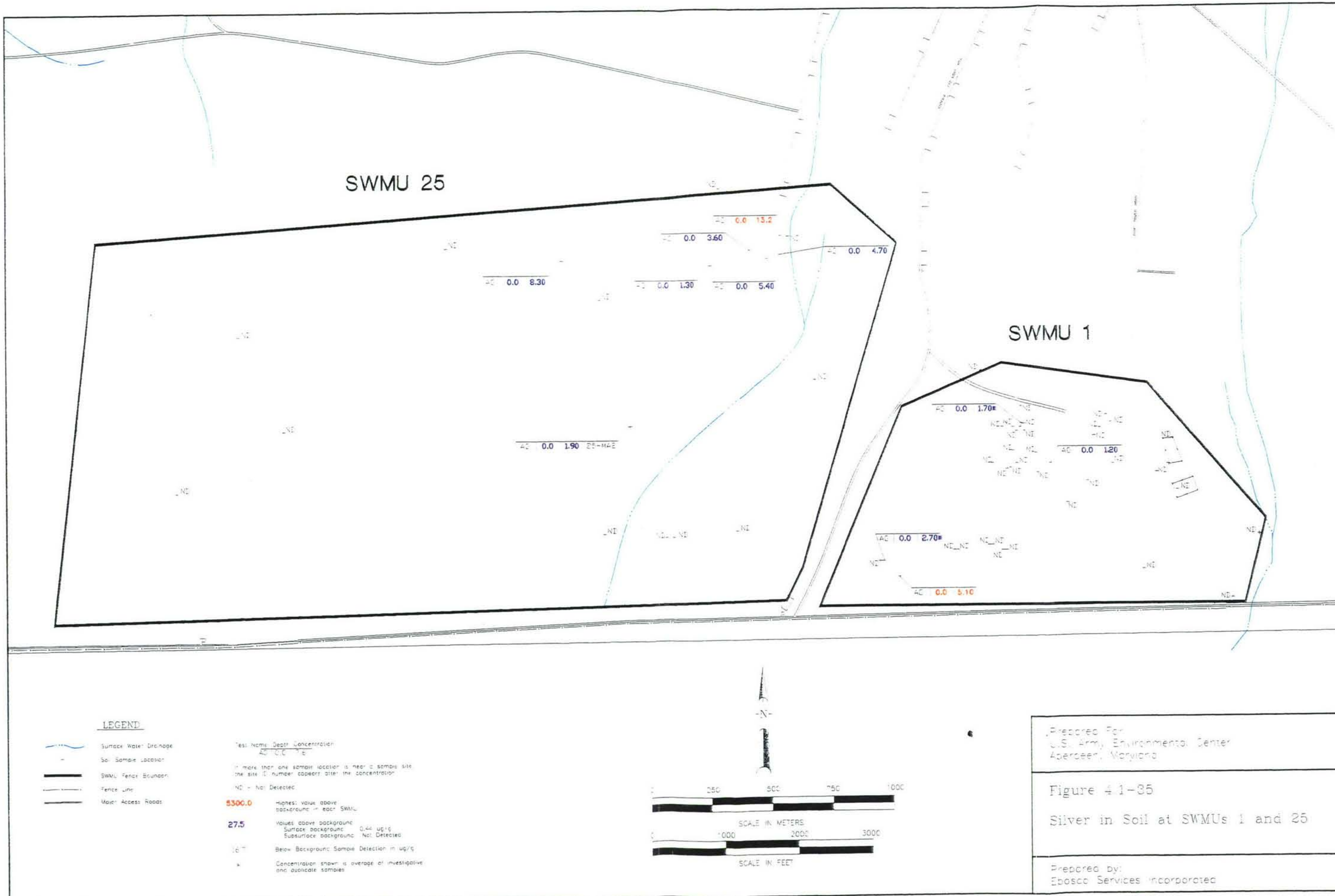
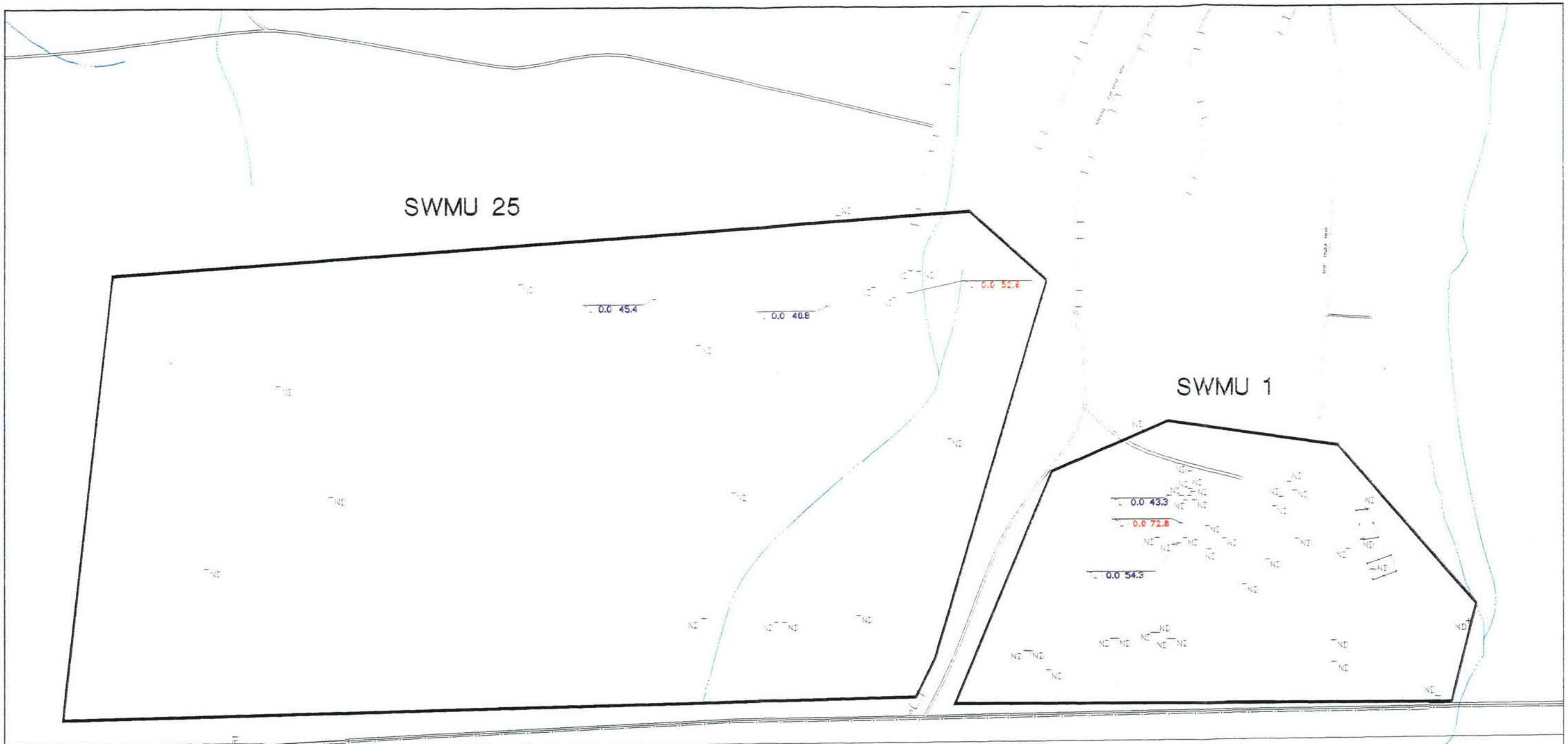


Figure 4.1-35

Silver in Soil at SWMUs 1 and 25



LEGEND

Surface Water Drainage
Soil Sample Location
SWMU Fence Boundary
Fence Line
Major Access Roads

Test Name Depth Concentration
L 0.0 45.5

If more than one sample location is near a sample site the site ID number appears after the concentration

ND = Not Detected

5300.0 Highest value above background in each SWMU

27.5 Values above background
Surface background 23.1 ug/g
Subsurface background 62.6 ug/g

16.7 Below Background Sample Detection in ug/g

* Concentration shown is average of investigative and duplicate samples

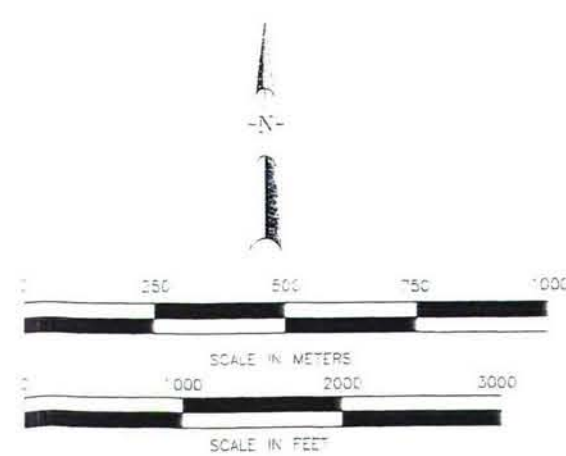


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Figure 4.1-36

Thallium in Soil at SWMUs 1 and 25

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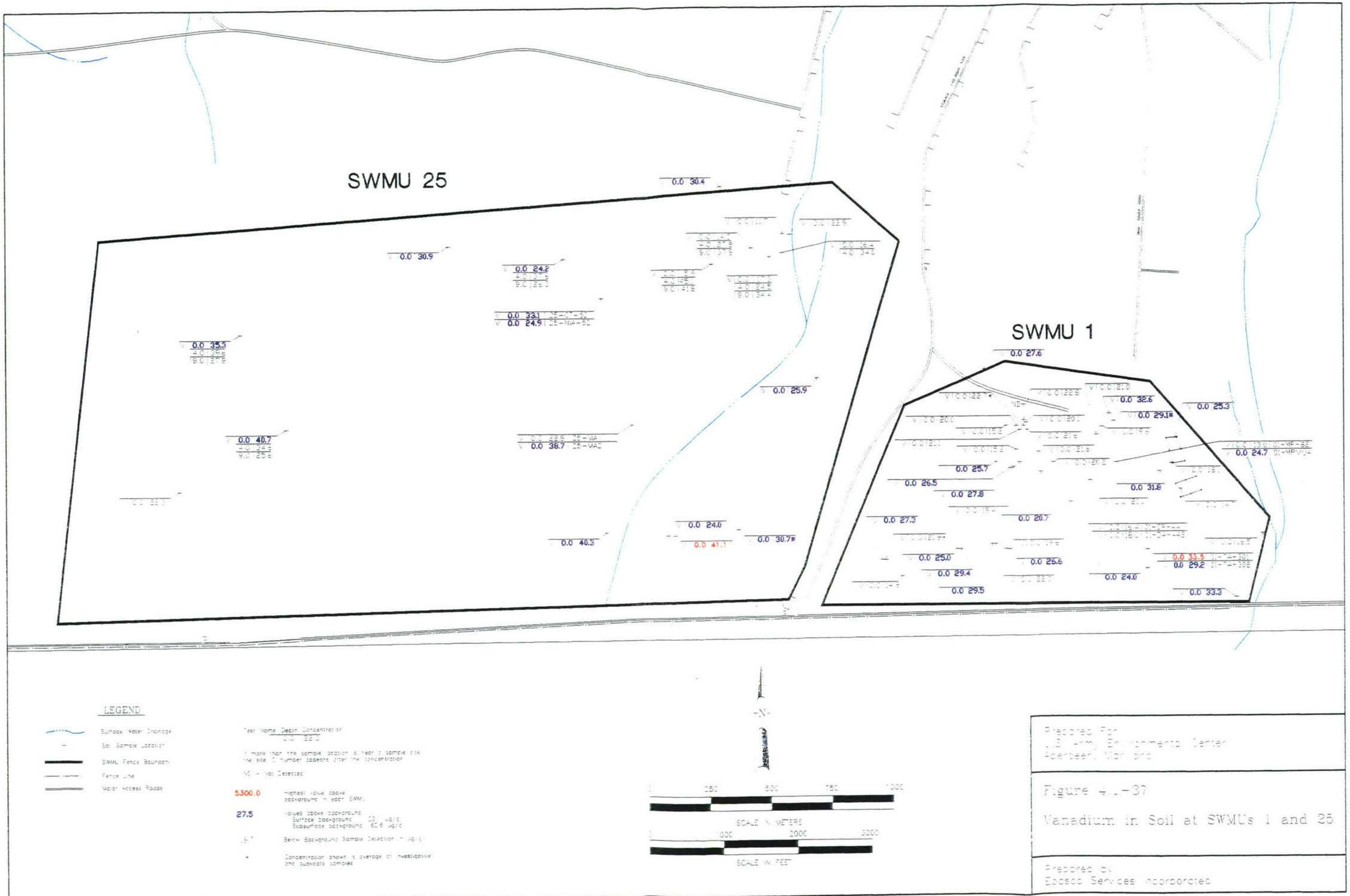

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Figure 4.1-37

Vanadium in Soil at SWMUs 1 and 25

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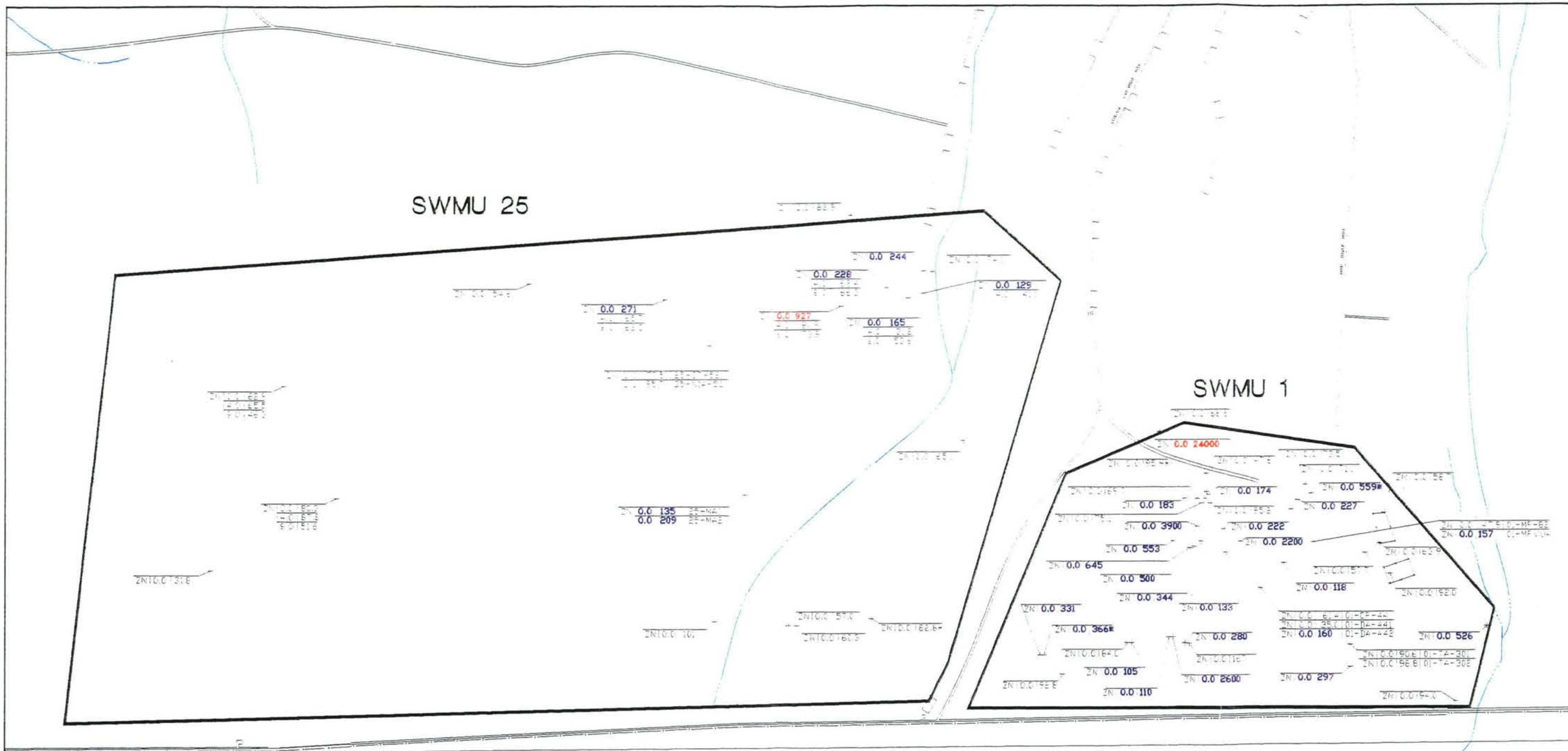

LEGEND

- Surface Water Drainage
- Soil Sample Location
- SWMU Fence Boundary
- Fence Line
- Major Access Roads

Test Name Depth Concentration
ZN 0.0 1010

If more than one sample location is near a sample site, the site ID number appears after the concentration

ND = Not Detected

5300.0 Highest value above background in each SWMU

27.5 Values above background
Surface background 104.0 ug/g
Subsurface background 144.0 ug/g

16.7 Below Background Sample Detection in ug/g

* Concentration shown is average of investigative and duplicate samples

-N-

0 250 500 750 1000
SCALE IN METERS

0 1000 2000 3000
SCALE IN FEET

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Aberdeen, Maryland

Figure 4.1-38

Zinc in Soil at SWMUs 1 and 25

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Analyte	Location	Depth (feet)	Value	Unit
SWMU1 - Covered and Open Trenches				
2MNAP	01-SPDA-77	0.100	0.230	UGG
AG	01-MP-89B	0.100	1.730	UGG
AG	01-SPDA-77	0.100	1.190	UGG
AL	01-CP-44	0.100	18200.000	UGG
AL	01-CP-63A	0.100	19400.000	UGG
AL	01-CP-89B	0.100	25500.000	UGG
AL	01-DA-442	0.100	18700.000	UGG
AL	01-HBA-84	0.100	19800.000	UGG
AL	01-HBA-92	0.100	26900.000	UGG
AL	01-HBA-93	0.100	22500.000	UGG
AL	01-IA-60	0.100	23000.000	UGG
AL	01-IA-80	0.100	20300.000	UGG
AL	01-MHA1	0.100	18500.000	UGG
AL	01-MHA2	0.100	25200.000	UGG
AL	01-MP-89	0.100	18300.000	UGG
AL	01-MP-89A	0.100	18300.000	UGG
AL	01-MPVU2	0.100	18700.000	UGG
AL	01-MSD-59	0.100	22600.000	UGG
AL	01-NBA-61	0.100	21000.000	UGG
AL	01-SPDA-77	0.100	32400.000	UGG
AL	01-TA-301	0.100	26800.000	UGG
AL	01-TA-302	0.100	24000.000	UGG
ANAPYL	01-SPDA-77	0.100	0.076	UGG
AS	01-HBA-93	0.100	34.350	UGG
AS	01-SPDA-99	0.100	33.000	UGG
B	01-CP-44	0.100	37.200	UGG
B	01-CP-63A	0.100	35.700	UGG
B	01-CP-89B	0.100	54.400	UGG
B	01-DA-442	0.100	40.700	UGG
B	01-HBA-84	0.100	46.700	UGG
B	01-HBA-85	0.100	28.400	UGG
B	01-HBA-92	0.100	46.500	UGG
B	01-HBA-93	0.100	64.300	UGG
B	01-IA-60	0.100	152.000	UGG
B	01-IA-80	0.100	34.300	UGG
B	01-IA-88	0.100	42.900	UGG
B	01-MHA1	0.100	27.100	UGG
B	01-MHA2	0.100	38.500	UGG
B	01-MHAU	0.100	32.500	UGG
B	01-MP-82	0.100	31.400	UGG
B	01-MP-89	0.100	31.100	UGG
B	01-MP-89A	0.100	32.300	UGG
B	01-MP-89B	0.100	35.700	UGG
B	01-MP-89C	0.100	38.800	UGG
B	01-MPVU1	0.100	28.600	UGG
B	01-MPVU2	0.100	28.500	UGG
B	01-MPVU3	0.100	25.300	UGG
B	01-MPVU4	0.100	33.000	UGG
B	01-MSD-58	0.100	48.500	UGG
B	01-MSD-59	0.100	48.500	UGG
B	01-NBA-61	0.100	35.400	UGG
B	01-PCA-74	0.100	42.700	UGG
B	01-PCA-88	0.100	19.700	UGG
B	01-SPDA-77	0.100	37.800	UGG
B	01-TA-301	0.100	53.800	UGG
B	01-TA-302	0.100	54.100	UGG
B2EHP	01-SPDA-99	0.100	8.400	UGG
BA	01-HBA-93	0.100	1200.000	UGG
BA	01-MP-89C	0.100	787.000	UGG
BA	01-MSD-59	0.100	801.000	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU1 - Covered and Open Trenches				
BA	01-SPDA-77	0.100	1600.000	UGG
BA	01-SPDA-99	0.100	1700.000	UGG
BA	01-TA-302	0.100	971.000	UGG
BE	01-CP-44	0.100	0.912	UGG
BE	01-HBA-92	0.100	0.968	UGG
BE	01-TA-301	0.100	1.150	UGG
BE	01-TA-302	0.100	0.895	UGG
CA	01-CP-44	0.100	180000.000	UGG
CA	01-DA-442	0.100	180000.000	UGG
CA	01-HBA-84	0.100	150000.000	UGG
CA	01-HBA-85	0.100	240000.000	UGG
CA	01-IA-88	0.100	210000.000	UGG
CA	01-MHA1	0.100	190000.000	UGG
CA	01-MHAU	0.100	180000.000	UGG
CA	01-MP-82	0.100	240000.000	UGG
CA	01-MP-89	0.100	150000.000	UGG
CA	01-MP-89B	0.100	170000.000	UGG
CA	01-MP-89C	0.100	240000.000	UGG
CA	01-MPVU1	0.100	200000.000	UGG
CA	01-NBA-61	0.100	160000.000	UGG
CA	01-PCA-74	0.100	220000.000	UGG
CA	01-PCA-88	0.100	160000.000	UGG
CD	01-CP-44	0.100	1.610	UGG
CD	01-HBA-93	0.100	2.370	UGG
CD	01-IA-60	0.100	1.560	UGG
CD	01-IA-80	0.100	3.900	UGG
CD	01-MP-89A	0.100	1.570	UGG
CD	01-MP-89B	0.100	3.400	UGG
CD	01-MP-89C	0.100	3.010	UGG
CD	01-MSD-58	0.100	2.790	UGG
CD	01-MSD-59	0.100	1.900	UGG
CD	01-NBA-61	0.100	1.930	UGG
CD	01-PCA-88	0.100	1.620	UGG
CD	01-SPDA-77	0.100	126.000	UGG
CD	01-SPDA-99	0.100	41.500	UGG
CD	01-TA-302	0.100	4.380	UGG
CL6BZ	01-SPDA-99	0.100	0.940	UGG
CO	01-CP-89B	0.100	6.640	UGG
CO	01-HBA-92	0.100	7.150	UGG
CO	01-MPVU4	0.100	7.280	UGG
CO	01-MSD-58	0.100	9.930	UGG
CO	01-PCA-88	0.100	8.260	UGG
CO	01-SPDA-99	0.100	52.000	UGG
CO	01-TA-301	0.100	7.020	UGG
CO	01-TA-302	0.100	6.980	UGG
CR	01-HBA-93	0.100	47.400	UGG
CR	01-IA-60	0.100	26.200	UGG
CR	01-MPVU4	0.100	36.500	UGG
CR	01-MSD-58	0.100	82.900	UGG
CR	01-MSD-59	0.100	43.500	UGG
CR	01-NBA-61	0.100	36.500	UGG
CR	01-PCA-88	0.100	29.500	UGG
CR	01-SPDA-77	0.100	67.400	UGG
CR	01-SPDA-99	0.100	279.000	UGG
CR	01-TA-302	0.100	42.400	UGG
CU	01-HBA-85	0.100	25.700	UGG
CU	01-HBA-92	0.100	27.100	UGG
CU	01-HBA-93	0.100	81.800	UGG
CU	01-IA-60	0.100	60.000	UGG
CU	01-IA-80	0.100	25.600	UGG

Recycled Paper

Analyte	Location	Depth (feet)	Value	Unit
SWMU 1 - Covered and Open Trenches				
CU	01-MHA1	0.100	37.000	UGG
CU	01-MHAU	0.100	41.100	UGG
CU	01-MP-89A	0.100	26.300	UGG
CU	01-MP-89B	0.100	31.600	UGG
CU	01-MPVU1	0.100	29.600	UGG
CU	01-MPVU2	0.100	30.200	UGG
CU	01-MPVU4	0.100	84.500	UGG
CU	01-MSD-58	0.100	192.000	UGG
CU	01-MSD-59	0.100	85.000	UGG
CU	01-NBA-61	0.100	32.300	UGG
CU	01-PCA-88	0.100	287.000	UGG
CU	01-SPDA-77	0.100	1440.000	UGG
CU	01-SPDA-99	0.100	832.000	UGG
CU	01-TA-302	0.100	76.200	UGG
CYN	01-IA-60	0.100	0.370	UGG
CYN	01-MSD-58	0.100	5.980	UGG
CYN	01-MSD-59	0.100	5.930	UGG
CYN	01-NBA-61	0.100	0.333	UGG
CYN	01-SPDA-77	0.100	0.426	UGG
CYN	01-SPDA-99	0.100	0.456	UGG
CYN	01-TA-302	0.100	0.317	UGG
DITH	01-TA-302	0.100	0.280	UGG
FC2A	01-MP-89B	0.100	2.470	UGG
FE	01-CP-89B	0.100	18700.000	UGG
FE	01-HBA-92	0.100	20100.000	UGG
FE	01-HBA-93	0.100	23150.000	UGG
FE	01-IA-60	0.100	33000.000	UGG
FE	01-IA-80	0.100	17800.000	UGG
FE	01-MHA2	0.100	20600.000	UGG
FE	01-MP-89B	0.100	22800.000	UGG
FE	01-MPVU4	0.100	73000.000	UGG
FE	01-MSD-58	0.100	99000.000	UGG
FE	01-MSD-59	0.100	18700.000	UGG
FE	01-NBA-61	0.100	28700.000	UGG
FE	01-PCA-88	0.100	93000.000	UGG
FE	01-SPDA-99	0.100	320000.000	UGG
FE	01-TA-301	0.100	20100.000	UGG
FE	01-TA-302	0.100	21900.000	UGG
HG	01-HBA-93	0.100	0.116	UGG
HG	01-MP-82	0.100	0.139	UGG
K	01-CP-63A	0.100	8380.000	UGG
K	01-CP-89B	0.100	9230.000	UGG
K	01-HBA-92	0.100	9540.000	UGG
K	01-IA-60	0.100	12000.000	UGG
K	01-IA-80	0.100	13500.000	UGG
K	01-IA-88	0.100	20300.000	UGG
K	01-MHA2	0.100	8910.000	UGG
K	01-MP-89A	0.100	8060.000	UGG
K	01-MSD-59	0.100	8150.000	UGG
K	01-TA-301	0.100	10100.000	UGG
K	01-TA-302	0.100	8820.000	UGG
MG	01-CP-44	0.100	43100.000	UGG
MG	01-CP-63A	0.100	29800.000	UGG
MG	01-CP-89B	0.100	55900.000	UGG
MG	01-DA-442	0.100	38100.000	UGG
MG	01-HBA-84	0.100	40300.000	UGG
MG	01-HBA-85	0.100	30800.000	UGG
MG	01-HBA-92	0.100	32800.000	UGG
MG	01-HBA-93	0.100	43050.000	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU 1 - Covered and Open Trenches				
MG	01-IA-60	0.100	21100.000	UGG
MG	01-IA-80	0.100	19100.000	UGG
MG	01-IA-88	0.100	19000.000	UGG
MG	01-MHA1	0.100	27000.000	UGG
MG	01-MHAU	0.100	31200.000	UGG
MG	01-MP-82	0.100	27700.000	UGG
MG	01-MP-89	0.100	18600.000	UGG
MG	01-MP-89C	0.100	19100.000	UGG
MG	01-MPVU1	0.100	18200.000	UGG
MG	01-MPVU2	0.100	19300.000	UGG
MG	01-MPVU4	0.100	28900.000	UGG
MG	01-MSD-58	0.100	16900.000	UGG
MG	01-MSD-59	0.100	28000.000	UGG
MG	01-NBA-61	0.100	21200.000	UGG
MG	01-PCA-74	0.100	20300.000	UGG
MG	01-SPDA-77	0.100	100000.000	UGG
MG	01-TA-301	0.100	30200.000	UGG
MG	01-TA-302	0.100	28900.000	UGG
MN	01-SPDA-99	0.100	1380.000	UGG
NA	01-IA-60	0.100	3840.000	UGG
NA	01-IA-80	0.100	1990.000	UGG
NA	01-IA-88	0.100	11500.000	UGG
NA	01-SPDA-77	0.100	1580.000	UGG
NI	01-MPVU4	0.100	35.700	UGG
NI	01-MSD-58	0.100	39.400	UGG
NI	01-NBA-61	0.100	20.400	UGG
NI	01-PCA-88	0.100	25.800	UGG
NI	01-SPDA-77	0.100	27.300	UGG
NI	01-SPDA-99	0.100	229.000	UGG
PB	01-DA-442	0.100	55.000	UGG
PB	01-HBA-93	0.100	61.000	UGG
PB	01-IA-60	0.100	45.000	UGG
PB	01-MP-89B	0.100	45.000	UGG
PB	01-MPVU2	0.100	37.000	UGG
PB	01-MSD-58	0.100	990.000	UGG
PB	01-MSD-59	0.100	49.000	UGG
PB	01-NBA-61	0.100	43.000	UGG
PB	01-PCA-74	0.100	85.000	UGG
PB	01-PCA-88	0.100	72.000	UGG
PB	01-SPDA-77	0.100	360.000	UGG
PB	01-SPDA-99	0.100	1100.000	UGG
PHANTR	01-SPDA-77	0.100	0.240	UGG
PYR	01-MP-82	0.100	0.180	UGG
SN	01-MSD-58	0.100	175.000	UGG
SN	01-SPDA-77	0.100	49.600	UGG
TL	01-IA-60	0.100	54.300	UGG
TL	01-PCA-88	0.100	72.800	UGG
V	01-CP-89B	0.100	31.800	UGG
V	01-HBA-92	0.100	32.600	UGG
V	01-HBA-93	0.100	29.150	UGG
V	01-IA-60	0.100	27.800	UGG
V	01-MHA2	0.100	25.300	UGG
V	01-MPVU4	0.100	24.700	UGG
V	01-MSD-58	0.100	25.700	UGG
V	01-MSD-59	0.100	26.500	UGG
V	01-TA-301	0.100	33.500	UGG
V	01-TA-302	0.100	29.200	UGG
ZN	01-CP-63A	0.100	118.000	UGG
ZN	01-DA-442	0.100	160.000	UGG

SWMU 1 - Covered and Open Trenches

Analyte	Location	Depth (feet)	Value	Unit
ZN	01-HBA-85	0.100	227.000	UGG
ZN	01-HBA-93	0.100	559.000	UGG
ZN	01-IA-60	0.100	500.000	UGG
ZN	01-IA-80	0.100	222.000	UGG
ZN	01-IA-88	0.100	183.000	UGG
ZN	01-MP-89B	0.100	174.000	UGG
ZN	01-MPVU4	0.100	157.000	UGG
ZN	01-MSD-58	0.100	553.000	UGG
ZN	01-MSD-59	0.100	645.000	UGG
ZN	01-NBA-61	0.100	133.000	UGG
ZN	01-PCA-74	0.100	344.000	UGG
ZN	01-PCA-88	0.100	3900.000	UGG
ZN	01-SPDA-77	0.100	2200.000	UGG
ZN	01-SPDA-99	0.100	24000.000	UGG

SWMU 1 - Crate Burning Area

Analyte	Location	Depth (feet)	Value	Unit
AG	01-CBA-8	0.100	5.130	UGG
AL	01-CBA-30	0.100	20600.000	UGG
AL	01-PBA-55	0.100	170000.000	UGG
B	01-CBA-30	0.100	34.400	UGG
B	01-CBA-8	0.100	17.000	UGG
B	01-PBA-55	0.100	14.900	UGG
BA	01-PBA-55	0.100	21000.000	UGG
CA	01-CBA-8	0.100	170000.000	UGG
CD	01-CBA-30	0.100	3.070	UGG
CD	01-PBA-55	0.100	141.000	UGG
CO	01-CBA-30	0.100	8.420	UGG
CO	01-PBA-55	0.100	26.800	UGG
CR	01-CBA-30	0.100	28.300	UGG
CR	01-PBA-55	0.100	5300.000	UGG
CU	01-CBA-30	0.100	58.300	UGG
CU	01-PBA-55	0.100	6700.000	UGG
FE	01-CBA-30	0.100	50000.000	UGG
FE	01-PBA-55	0.100	210000.000	UGG
K	01-CBA-30	0.100	8480.000	UGG
MG	01-CBA-30	0.100	21700.000	UGG
MN	01-CBA-30	0.100	704.000	UGG
MN	01-PBA-55	0.100	2300.000	UGG
MO	01-PBA-55	0.100	38.500	UGG
NI	01-CBA-30	0.100	28.400	UGG
NI	01-PBA-55	0.100	456.000	UGG
PB	01-CBA-30	0.100	44.000	UGG
PB	01-PBA-55	0.100	71.000	UGG
SB	01-PBA-55	0.100	26.300	UGG
SN	01-PBA-55	0.100	27.100	UGG
V	01-CBA-30	0.100	24.000	UGG
ZN	01-CBA-30	0.100	297.000	UGG
ZN	01-PBA-55	0.100	526.000	UGG

SWMU 1 - Incendiary Burning Area

Analyte	Location	Depth (feet)	Value	Unit
AG	01-IAM-8	0.100	2.665	UGG
AL	01-IAM-11	0.100	24300.000	UGG
AL	01-IAM-13	0.100	19500.000	UGG
AL	01-IAM-15	0.100	31100.000	UGG
AL	01-IAM-8	0.100	31650.000	UGG
AL	01-IBA1	0.100	21300.000	UGG
AL	01-IBA2	0.100	22100.000	UGG
AL	01-IBA3	0.100	19700.000	UGG
AL	01-IBA4	0.100	20600.000	UGG
AS	01-IAM-13	0.100	77.000	UGG
B	01-IAM-11	0.100	52.400	UGG

SWMU 1 - Incendiary Burning Area

Analyte	Location	Depth (feet)	Value	Unit
B	01-IAM-13	0.100	21.300	UGG
B	01-IAM-15	0.100	21.400	UGG
B	01-IAM-8	0.100	24.950	UGG
B	01-IBA1	0.100	40.000	UGG
B	01-IBA2	0.100	32.000	UGG
B	01-IBA3	0.100	29.700	UGG
B	01-IBA4	0.100	26.500	UGG
BA	01-IAM-11	0.100	3000.000	UGG
BA	01-IAM-13	0.100	3700.000	UGG
BA	01-IAM-15	0.100	9800.000	UGG
BA	01-IAM-8	0.100	10650.000	UGG
CD	01-IAM-13	0.100	2.680	UGG
CD	01-IAM-15	0.100	2.020	UGG
CD	01-IAM-8	0.100	2.430	UGG
CO	01-IAM-13	0.100	13.300	UGG
CO	01-IAM-15	0.100	10.100	UGG
CO	01-IBA2	0.100	7.340	UGG
CR	01-IAM-11	0.100	68.300	UGG
CR	01-IAM-13	0.100	79.600	UGG
CR	01-IAM-15	0.100	833.000	UGG
CR	01-IAM-8	0.100	532.500	UGG
CR	01-IBA1	0.100	28.700	UGG
CR	01-IBA4	0.100	40.300	UGG
CU	01-IAM-11	0.100	260.000	UGG
CU	01-IAM-13	0.100	505.000	UGG
CU	01-IAM-15	0.100	1800.000	UGG
CU	01-IAM-8	0.100	894.500	UGG
CU	01-IBA1	0.100	40.400	UGG
CU	01-IBA4	0.100	37.700	UGG
CYN	01-IAM-11	0.100	0.644	UGG
CYN	01-IAM-13	0.100	0.799	UGG
CYN	01-IAM-15	0.100	2.300	UGG
CYN	01-IAM-8	0.100	2.105	UGG
FE	01-IAM-13	0.100	120000.000	UGG
FE	01-IAM-15	0.100	110000.000	UGG
FE	01-IAM-8	0.100	40300.000	UGG
FE	01-IBA1	0.100	20200.000	UGG
FE	01-IBA4	0.100	19000.000	UGG
HG	01-IAM-13	0.100	0.171	UGG
HG	01-IBA1	0.100	0.143	UGG
K	01-IBA1	0.100	8880.000	UGG
MG	01-IAM-11	0.100	72000.000	UGG
MG	01-IAM-13	0.100	52600.000	UGG
MG	01-IAM-15	0.100	84000.000	UGG
MG	01-IAM-8	0.100	83200.000	UGG
MG	01-IBA1	0.100	22700.000	UGG
MG	01-IBA2	0.100	19300.000	UGG
MG	01-IBA3	0.100	25600.000	UGG
MG	01-IBA4	0.100	16800.000	UGG
MN	01-IAM-13	0.100	730.000	UGG
MN	01-IAM-15	0.100	872.000	UGG
MN	01-IAM-8	0.100	683.500	UGG
NI	01-IAM-13	0.100	47.700	UGG
NI	01-IAM-15	0.100	102.000	UGG
NI	01-IAM-8	0.100	62.100	UGG
PB	01-IAM-13	0.100	330.000	UGG
PB	01-IAM-8	0.100	77.000	UGG
SN	01-IAM-13	0.100	19.200	UGG
SN	01-IAM-15	0.100	11.100	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU 1 - Incendiary Burning Area				
TE	01-IAM-13	0.100	23.100	UGG
V	01-IAM-11	0.100	29.400	UGG
V	01-IBA1	0.100	26.600	UGG
V	01-IBA2	0.100	29.500	UGG
V	01-IBA3	0.100	25.000	UGG
V	01-IBA4	0.100	27.300	UGG
ZN	01-IAM-11	0.100	105.000	UGG
ZN	01-IAM-13	0.100	2600.000	UGG
ZN	01-IAM-15	0.100	280.000	UGG
ZN	01-IAM-8	0.100	366.000	UGG
ZN	01-IBA1	0.100	167.000	UGG
ZN	01-IBA2	0.100	110.000	UGG
ZN	01-IBA4	0.100	331.000	UGG
SWMU 1 - Other Areas				
AL	01-NEAS1	0.100	22400.000	UGG
AL	01-SEC1	0.100	25100.000	UGG
B	01-NEAS1	0.100	26.900	UGG
B	01-SEC1	0.100	37.900	UGG
CO	01-NEAS1	0.100	7.290	UGG
CO	01-SEC1	0.100	6.800	UGG
CR	01-SEC1	0.100	25.700	UGG
CU	01-SEC1	0.100	29.300	UGG
FE	01-SEC1	0.100	19500.000	UGG
K	01-SEC1	0.100	9330.000	UGG
MG	01-NEAS1	0.100	21500.000	UGG
MG	01-SEC1	0.100	17800.000	UGG
V	01-NEAS1	0.100	27.600	UGG
V	01-SEC1	0.100	33.300	UGG
SWMU 25 - Ash Mounds				
AG	25-AM-58	0.100	1.330	UGG
AL	25-AM-58	4.500	31550.000	UGG
B	25-AM-58	4.500	36.450	UGG
B	25-AM-58	9.500	23.100	UGG
B2EHP	25-AM-58	0.100	5.400	UGG
B2EHP	25-AM-58	4.500	2.200	UGG
BA	25-AM-58	0.100	8600.000	UGG
CA	25-AM-58	9.500	270000.000	UGG
CD	25-AM-58	0.100	2.060	UGG
CO	25-AM-58	4.500	9.570	UGG
CR	25-AM-58	0.100	365.000	UGG
CU	25-AM-58	0.100	402.000	UGG
CYN	25-AM-58	0.100	0.582	UGG
K	25-AM-58	4.500	5760.000	UGG
MG	25-AM-58	0.100	230000.000	UGG
MG	25-AM-58	4.500	28200.000	UGG
MG	25-AM-58	9.500	22300.000	UGG
MN	25-AM-58	9.500	508.000	UGG
NI	25-AM-58	0.100	26.500	UGG
PB	25-AM-58	0.100	42.000	UGG
TETRYL	25-AM-58	0.100	77.900	UGG
ZN	25-AM-58	0.100	927.000	UGG
SWMU 25 - Covered Trenches				
AG	25-MA2	0.100	1.920	UGG
AL	25-CT-07	0.100	34100.000	UGG
AL	25-CT-08	0.100	27700.000	UGG
AL	25-IDC-10	0.100	20250.000	UGG
AL	25-MA2	0.100	30300.000	UGG
B	25-CT-07	0.100	42.900	UGG
B	25-CT-08	0.100	48.300	UGG
SWMU 1 - Covered Trenches				
B	25-IDC-10	0.100	45.950	UGG
B	25-MA1	0.100	27.200	UGG
B	25-MA2	0.100	45.200	UGG
B	25-UA3	0.100	21.900	UGG
B2EHP	25-CT-07	0.100	2.900	UGG
B2EHP	25-CT-08	0.100	2.700	UGG
B2EHP	25-MA1	0.100	2.200	UGG
B2EHP	25-MA2	0.100	2.300	UGG
BE	25-CT-07	0.100	1.000	UGG
BE	25-CT-08	0.100	0.915	UGG
BE	25-MA2	0.100	0.906	UGG
CA	25-MA1	0.100	160000.000	UGG
CD	25-MA1	0.100	2.340	UGG
CD	25-MA2	0.100	3.450	UGG
CO	25-CT-07	0.100	8.570	UGG
CO	25-CT-08	0.100	7.200	UGG
CO	25-MA2	0.100	8.850	UGG
CR	25-CT-07	0.100	36.200	UGG
CR	25-CT-08	0.100	26.100	UGG
CR	25-IDC-10	0.100	25.250	UGG
CR	25-MA2	0.100	37.000	UGG
CU	25-CT-07	0.100	32.600	UGG
CU	25-MA1	0.100	65.000	UGG
CU	25-MA2	0.100	104.000	UGG
DNBP	25-CT-07	0.100	6.200	UGG
FE	25-CT-07	0.100	23200.000	UGG
FE	25-CT-08	0.100	19800.000	UGG
FE	25-MA2	0.100	24000.000	UGG
HG	25-CT-07	0.100	0.305	UGG
K	25-CT-07	0.100	11100.000	UGG
K	25-CT-08	0.100	10500.000	UGG
K	25-MA2	0.100	10300.000	UGG
MG	25-CT-07	0.100	28900.000	UGG
MG	25-CT-08	0.100	39500.000	UGG
MG	25-IDC-10	0.100	28750.000	UGG
MG	25-MA1	0.100	16300.000	UGG
MG	25-MA2	0.100	21300.000	UGG
NA	25-CT-08	0.100	1550.000	UGG
NI	25-CT-07	0.100	23.200	UGG
NI	25-MA2	0.100	22.100	UGG
PB	25-CT-07	0.100	56.000	UGG
PB	25-MA1	0.100	120.000	UGG
PB	25-MA2	0.100	140.000	UGG
PB	25-UA3	0.100	35.000	UGG
SN	25-MA2	0.100	10.100	UGG
V	25-CT-07	0.100	40.300	UGG
V	25-CT-08	0.100	41.100	UGG
V	25-IDC-10	0.100	30.650	UGG
V	25-MA2	0.100	38.700	UGG
V	25-UA3	0.100	24.000	UGG
ZN	25-MA1	0.100	135.000	UGG
ZN	25-MA2	0.100	209.000	UGG
SWMU 25 - High Explosive Craters				
AL	25-ODC-108	4.500	29900.000	UGG
AL	25-ODC-110	0.100	34600.000	UGG
AL	25-ODC-110	4.500	31800.000	UGG
AL	25-ODC-92	(100	19800.000	UGG
B	25-ODC-108	0.100	32.300	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU 25 - High Explosive Craters				
B	25-ODC-108	4.500	53.200	UGG
B	25-ODC-108	9.500	30.000	UGG
B	25-ODC-110	0.100	69.300	UGG
B	25-ODC-110	4.500	76.000	UGG
B	25-ODC-110	9.500	54.400	UGG
B	25-ODC-119	0.100	24.000	UGG
B	25-ODC-92	0.100	47.600	UGG
BE	25-ODC-110	0.100	1.280	UGG
BE	25-ODC-110	4.500	1.440	UGG
CA	25-ODC-119	0.100	210000.000	UGG
CO	25-ODC-108	0.100	7.480	UGG
CO	25-ODC-110	0.100	6.760	UGG
CR	25-ODC-108	0.100	27.500	UGG
CR	25-ODC-110	0.100	25.300	UGG
FE	25-ODC-108	0.100	20100.000	UGG
FE	25-ODC-110	0.100	27500.000	UGG
FE	25-ODC-110	4.500	28800.000	UGG
FE	25-ODC-92	0.100	17600.000	UGG
K	25-ODC-108	0.100	8340.000	UGG
K	25-ODC-108	4.500	11200.000	UGG
K	25-ODC-108	9.500	7030.000	UGG
K	25-ODC-110	0.100	14700.000	UGG
K	25-ODC-110	4.500	14700.000	UGG
K	25-ODC-110	9.500	9130.000	UGG
MG	25-ODC-108	0.100	17400.000	UGG
MG	25-ODC-108	4.500	18700.000	UGG
MG	25-ODC-108	9.500	18000.000	UGG
MG	25-ODC-110	0.100	21500.000	UGG
MG	25-ODC-110	4.500	22600.000	UGG
MG	25-ODC-110	9.500	18100.000	UGG
MG	25-ODC-119	0.100	42300.000	UGG
MG	25-ODC-92	0.100	48500.000	UGG
NA	25-ODC-110	0.100	2640.000	UGG
NA	25-ODC-110	4.500	6140.000	UGG
NA	25-ODC-110	9.500	6470.000	UGG
SB	25-ODC-110	0.100	35.700	UGG
V	25-ODC-108	0.100	35.300	UGG
V	25-ODC-110	0.100	40.700	UGG
V	25-ODC-92	0.100	30.900	UGG
SWMU 25 - Incendiary Burning Area				
AG	25-IBA-59	0.100	3.580	UGG
AG	25-IBA-60	0.100	5.390	UGG
AG	25-IBA-65	0.100	4.690	UGG
AG	25-IBA-67	0.100	13.200	UGG
AL	25-CT-52	0.100	24600.000	UGG
AL	25-IBA-59	0.100	32000.000	UGG
AL	25-IBA-59	9.500	25600.000	UGG
AL	25-IBA-60	0.100	37900.000	UGG
AL	25-IBA-65	0.100	36100.000	UGG
AL	25-IBA-67	0.100	43100.000	UGG
AL	25-NIA-52	0.100	19900.000	UGG
B	25-CT-52	0.100	35.300	UGG
B	25-IBA-59	0.100	31.100	UGG
B	25-IBA-59	4.500	39.800	UGG
B	25-IBA-59	9.500	41.200	UGG
B	25-IBA-60	0.100	21.300	UGG
B	25-IBA-60	5.000	27.300	UGG
B	25-IBA-60	10.000	34.700	UGG
B	25-IBA-65	0.100	23.200	UGG
SWMU 25 - Incendiary Burning Area				
B	25-IBA-65	4.500	23.700	UGG
B	25-IBA-67	0.100	19.400	UGG
B	25-NIA-52	0.100	29.300	UGG
B2EHP	25-CT-52	0.100	2.500	UGG
B2EHP	25-NIA-52	0.100	2.800	UGG
BA	25-CT-52	0.100	771.000	UGG
BA	25-IBA-59	0.100	7500.000	UGG
BA	25-IBA-59	4.500	589.000	UGG
BA	25-IBA-60	0.100	15000.000	UGG
BA	25-IBA-65	0.100	18000.000	UGG
BA	25-IBA-67	0.100	18000.000	UGG
BA	25-NIA-52	0.100	724.000	UGG
BAANTR	25-IBA-60	0.100	0.130	UGG
BKFANT	25-IBA-60	0.100	0.310	UGG
CD	25-IBA-59	0.100	1.560	UGG
CD	25-IBA-60	0.100	1.980	UGG
CD	25-IBA-67	0.100	1.870	UGG
CD	25-NIA-52	0.100	1.970	UGG
CHRY	25-IBA-60	0.100	0.200	UGG
CO	25-CT-52	0.100	7.780	UGG
CO	25-IBA-59	0.100	8.360	UGG
CO	25-IBA-65	0.100	13.400	UGG
CO	25-IBA-67	0.100	13.000	UGG
CO	25-NIA-52	0.100	7.070	UGG
CR	25-CT-52	0.100	68.400	UGG
CR	25-IBA-59	0.100	452.000	UGG
CR	25-IBA-60	0.100	658.000	UGG
CR	25-IBA-65	0.100	1400.000	UGG
CR	25-IBA-67	0.100	772.000	UGG
CR	25-NIA-52	0.100	43.000	UGG
CU	25-CT-52	0.100	85.500	UGG
CU	25-IBA-59	0.100	1140.000	UGG
CU	25-IBA-60	0.100	1900.000	UGG
CU	25-IBA-65	0.100	2000.000	UGG
CU	25-IBA-67	0.100	2300.000	UGG
CU	25-NIA-52	0.100	149.000	UGG
CYN	25-IBA-59	0.100	1.670	UGG
CYN	25-IBA-60	0.100	8.630	UGG
CYN	25-IBA-65	0.100	7.070	UGG
CYN	25-IBA-67	0.100	18.000	UGG
CYN	25-NIA-52	0.100	0.392	UGG
FANT	25-IBA-60	0.100	0.350	UGG
FE	25-CT-52	0.100	19900.000	UGG
FE	25-IBA-59	0.100	42700.000	UGG
FE	25-IBA-60	0.100	51300.000	UGG
FE	25-IBA-65	0.100	44300.000	UGG
FE	25-IBA-67	0.100	48300.000	UGG
FE	25-NIA-52	0.100	24000.000	UGG
K	25-CT-52	0.100	8750.000	UGG
K	25-IBA-59	4.500	5670.000	UGG
K	25-IBA-59	9.500	6390.000	UGG
K	25-IBA-60	10.000	5170.000	UGG
MG	25-CT-52	0.100	34100.000	UGG
MG	25-IBA-59	0.100	110000.000	UGG
MG	25-IBA-59	4.500	33500.000	UGG
MG	25-IBA-59	9.500	26000.000	UGG
MG	25-IBA-60	0.100	100000.000	UGG
MG	25-IBA-60	5.000	47700.000	UGG
MG	25-IBA-60	10.000	49900.000	UGG

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Analyte	Location	Depth (feet)	Value	Unit
SWMU 25 - Incendiary Burning Area				
MG	25-IBA-65	0.100	75000.000	UGG
MG	25-IBA-67	0.100	130000.000	UGG
MG	25-NIA-52	0.100	24500.000	UGG
MN	25-IBA-59	0.100	784.000	UGG
MN	25-IBA-60	0.100	764.000	UGG
MN	25-IBA-65	0.100	836.000	UGG
MN	25-IBA-67	0.100	832.000	UGG
NI	25-IBA-59	0.100	61.600	UGG
NI	25-IBA-60	0.100	85.200	UGG
NI	25-IBA-65	0.100	75.500	UGG
NI	25-IBA-67	0.100	78.900	UGG
PB	25-IBA-59	0.100	280.000	UGG
PB	25-IBA-60	0.100	300.000	UGG
PB	25-IBA-65	0.100	180.000	UGG
PB	25-IBA-67	0.100	410.000	UGG
PB	25-NIA-52	0.100	70.000	UGG
PHANTR	25-IBA-60	0.100	0.440	UGG
PPDDD	25-IBA-60	0.100	2.200	UGG
PPDDE	25-IBA-60	0.100	0.780	UGG
PPDDT	25-IBA-60	0.100	0.410	UGG
PYR	25-IBA-60	0.100	0.480	UGG
SB	25-IBA-67	0.100	81.000	UGG
SN	25-IBA-59	0.100	10.600	UGG
SN	25-IBA-60	0.100	19.700	UGG
SN	25-IBA-65	0.100	9.800	UGG
TL	25-IBA-65	0.100	52.600	UGG
V	25-CT-52	0.100	33.100	UGG
V	25-NIA-52	0.100	24.900	UGG
ZN	25-IBA-59	0.100	228.000	UGG
ZN	25-IBA-60	0.100	165.000	UGG
ZN	25-IBA-65	0.100	129.000	UGG
ZN	25-IBA-67	0.100	244.000	UGG
SWMU 25 - Other Areas				
AL	25-NWAS	0.100	21700.000	UGG
AL	25-UA1	0.100	17900.000	UGG
AL	25-UA2	0.100	18300.000	UGG
B	25-NWAS	0.100	33.100	UGG
B	25-UA1	0.100	22.600	UGG
B	25-UA2	0.100	29.400	UGG
B2EHP	25-NWAS	0.100	3.200	UGG
BA	25-UA1	0.100	2000.000	UGG
CD	25-NWAS	0.100	1.620	UGG
CD	25-UA1	0.100	1.960	UGG
CR	25-NWAS	0.100	38.600	UGG
CR	25-UA1	0.100	34.500	UGG
CU	25-NWAS	0.100	31.500	UGG
CU	25-UA1	0.100	89.200	UGG
FE	25-NWAS	0.100	18100.000	UGG
FE	25-UA1	0.100	19200.000	UGG
K	25-NWAS	0.100	8980.000	UGG
MG	25-NWAS	0.100	19800.000	UGG
MG	25-UA2	0.100	22400.000	UGG
PB	25-UA1	0.100	35.000	UGG
V	25-NWAS	0.100	30.400	UGG
V	25-UA2	0.100	25.900	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU 25 - Windrows				
AG	25-WIND	0.100	8.290	UGG
AL	25-WIND	0.100	32200.000	UGG
AL	25-WIND	4.500	30100.000	UGG
B	25-WIND	0.100	26.200	UGG
B	25-WIND	4.500	48.700	UGG
B	25-WIND	9.500	32.500	UGG
B2EHP	25-WIND	4.500	1.400	UGG
B2EHP	25-WIND	9.500	3.100	UGG
BA	25-WIND	0.100	9800.000	UGG
CD	25-WIND	0.100	4.590	UGG
CO	25-WIND	0.100	13.400	UGG
CR	25-WIND	0.100	356.000	UGG
CU	25-WIND	0.100	1800.000	UGG
CYN	25-WIND	0.100	4.960	UGG
DNBP	25-WIND	4.500	5.600	UGG
FE	25-WIND	0.100	190000.000	UGG
K	25-WIND	4.500	8440.000	UGG
K	25-WIND	9.500	6080.000	UGG
MG	25-WIND	0.100	53300.000	UGG
MG	25-WIND	4.500	41800.000	UGG
MG	25-WIND	9.500	38800.000	UGG
MN	25-WIND	0.100	920.000	UGG
NI	25-WIND	0.100	151.000	UGG
PB	25-WIND	0.100	300.000	UGG
SE	25-WIND	0.100	2.650	UGG
SN	25-WIND	0.100	17.300	UGG
TETRYL	25-WIND	4.500	33.700	UGG
V	25-WIND	0.100	24.200	UGG
ZN	25-WIND	0.100	271.000	UGG

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At sample locations where duplicates were taken (01-HBA-93, 01-IAM-8, 25-AM-58-4.5 ft depth interval, 25-IDC-10) the results of the original sample and duplicate were averaged and posted on the figures.

Organic Compounds

The results of analyses for VOCs, SVOCs, explosives and agent breakdown products in SWMU 1 included only seven individual analytes detected in a small number of scattered samples at relatively low levels (Figure 0). Target organic analytes were detected at only five locations within SWMU 1. The detections were scattered in the covered and open trenches source area. Three of the eight analytes were detected at one location (01-SPDA-77), and two analytes were found at another (01-SPDA-99). No more than one organic analyte was detected at any other location.

The analytical results for SWMU 25 were similar. Four locations were found to contain 11 different analytes. As in SWMU 1, the detected levels of these analytes were quite low, with the exception of the explosive Tetryl, which was found in the windrows and ash mounds source areas. Bis(2-ethylhexyl)phthalate, a common plasticizer, was detected in one sample from SWMU 1. It was also detected at low concentrations in six samples from SWMU 25. For the SWMU 25 samples, bis(2-ethylhexyl)phthalate was also detected in the respective laboratory blank for each sample (see Section 3.11.3.1.). Due to the uniform spatial distribution, low concentrations, and presence of bis(2-ethylhexyl)phthalate in laboratory blanks for all by one sample, it is likely that these detections represent sample handling and laboratory contamination rather than site contamination. The surficial sample at 25-IBA-60 contained nine SVOCs that are probably related to the use of fuels and waste products to aid in munitions burning. No analytes were detected in the subsurface samples at this location. Di-n-butyl phthalate was detected in three samples. This compound is a component of some explosives and is also a common plasticizer that could have been introduced during sampling or laboratory analysis.

Metals

Metals above background were distributed more widely than organic detections, but approximately two-thirds of sample locations in SWMUs 1 and 25 indicate minimal or no contamination in surface soil. The distribution of most metals, including aluminum, barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc, is similar. These analytes generally occurred above background in the central portion of the covered and open trenches and the incendiary burning areas of SWMU 1. They are also common in the

windrows, ash mounds and incendiary burn areas of SWMU 25. A subset of these analytes, including aluminum, chromium, cobalt, and vanadium were also detected above background in the high explosive craters area of SWMU 25. With the exception of barium, cadmium, and zinc, all of the above metals were also detected above background in the SWMU 25 covered trenches area. Silver had a similar pattern of occurrence; however, it was detected with less frequency than the metals above.

The highest metals concentrations in SWMU 1 occurred at three sample locations. Two of these samples (01-SPDA-77 and 01-SPDA-99) were collected from the covered and open trench source area, and one sample (01-PBA-55) was taken from the crate burn area. The sample from the crate burn area, which was the site of propellant disposal, contains the highest number of maximum observed concentrations. The other locations are associated with smoke pot disposal. Organic detections in SWMU 1 occur at both smoke pot disposal areas and scattered over other areas, seemingly at random. Incendiary Burn area samples also contained many concentrations above background.

The high concentrations of metals and other analytes in SWMU 25 generally occur in the northeastern quadrant. The source areas in this part of the SWMU include the incendiary burn, ash mounds and windrows areas. The highest levels of metals generally occur in the surficial soil layer in one of the four incendiary burn area samples.

Concentrations above background of antimony, arsenic, beryllium, mercury, and thallium (Figures 2, 3, 5, and 4.1-33, and 4.1-36, respectively) are significantly fewer than those of the previously discussed metals, especially for antimony and mercury. Also, the distribution of antimony, arsenic and mercury values above background did not follow the typical spatial pattern of the other metals.

No surficial background value was established for antimony, as there were no detections in background samples, and it appeared in only three locations where values were approximately two to seven times above the established subsurface background level (Figure 2). These detections were widely spaced in SWMUs 1 and 25.

Arsenic was above background at only three locations in SWMU 1. At two of these locations, arsenic levels are very close to the background value (Figure 3).

The beryllium distribution (Figure 5) was different from the distribution of most other metals. It was not detected above background in the SWMU 25 windrows, ash mounds and incendiary burn areas and was detected only sporadically in SWMU 1. All detections in surface and subsurface soil were near background. Based on these observations and the presence of beryllium mineral deposits in the adjacent mountains, it appears that beryllium in this area of TEAD-S is naturally occurring and not related to sources of contamination.

Mercury detections were also sparse, with only five detections above background (Figure 4.1-33). Except for one value in SWMU 25, these concentrations are very close to background. Unlike most other metals, mercury was not detected in the most contaminated areas of the SWMU 1 covered and open trenches or the northeastern portion of SWMU 25. The highest mercury concentration was found in a SWMU 25 sample from the covered trench source area. This sample contained near background levels of all other metals.

Thallium detections were limited to six detections above background, three locations in each SWMU (Figure 4.1-36). All detections were in surficial soil samples, with three of the detections below background (49.9 µg/g). The highest concentration of thallium (52.6 µg/g) detected in SWMU 25 and one of the two above-background detections in SWMU 1 were close to the background. The highest concentration detected (72.8 µg/g) was in a SWMU 1 sample from the covered and open trenches area.

Solid Waste

A single solid waste sample was taken from the covered and open trench source area in SWMU 1. This sample (01-DA-441) was collected from a container of super tropical bleach (STB) which was commonly used by Army personnel for agent decontamination. Only a few metals were detected at low concentrations and none of the metals were near or above background. No other analytes were detected in this sample.

Testhole Results

During drilling of the well S-93-92 borehole, four soil samples were collected and submitted for chemical analysis. This location was named "Testhole," and is located outside the southeast corner of SWMU 1. The four samples were collected from the 74-76, 104-106, 119-121, and 129-131 ft depth intervals. These intervals corresponded to moist zones where well completion was originally planned.

All the testhole samples were analyzed for the full suite of contaminants. The only analytes detected were metals. Table 4.1-9 presents the metals detection and background values.

Table 4.1-9 Metal Detections in Testhole Samples

	Analyte											
Depth(ft)	Al	As	Ba	Be	Co	Cu	Cr	Hg	Ni	Mn	V	Zn
74-76	23,500	11.9	278.0	0.96	6.7	11.7	15.5	—	13.6	351.0	23.7	48.3
104-106	60,000	11.0	532.0	1.99	14.1	21.3	44.4	0.20	27.3	823.0	75.5	102.0
119-121	25,400	31.9	248.0	0.81	6.4	12.1	18.0	—	12.8	390.0	32.5	50.9
129-131	31,100	8.3	345.0	1.27	9.4	15.6	15.7	—	15.4	498.0	34.4	61.5
BKGD	25,200	40.3	423.0	1.20	8.6	27.5	48.5	0.14	27.9	474.0	62.6	144.0

Values in micrograms/gram (μg/g)
Please see Chemical Acronym List for acronym definitions.

Metals above background were detected at depths of 105 ft, 120 ft, and 130 ft. Considering the depths at which metals were detected, the values are most likely the result of natural conditions.

4.1.2.2 Soil Gas Results

A soil gas survey was conducted to delineate potential fuel-contamination sources near well S-66-90 in SWMU 25 and to aid in groundwater monitoring well placement outside the southeastern corner of SWMU 1 (Figure 4.1-39). The soil gas samples were analyzed for benzene, toluene, xylene, trichloroethylene, and tetrachloroethylene to evaluate whether fuels and solvents were released during munitions burning. The nature of the soil content at SWMU 25 and SWMU 1 placed some restrictions on the soil gas survey. Due to background interference, the reporting limits (RL) had to be raised slightly so that contamination could be distinguished from ambient background levels. In addition, the reproducibility of duplicate analyses was affected. The same contaminants were present in the duplicates, but at lower levels. There also appeared to be some contaminant carryover, but raising the RL helped to correct for this.

Eleven lines of samples were screened at SWMU 25. These lines are illustrated in Figure 4.1-39. VOCs were measured at higher concentrations (up to 1,000 ppb) in the north-eastern and north-central sections of the SWMU where the windrows, ash mounds, and burn pits are located. In the southern areas of the SWMU, the concentrations begin to decrease and eventually become

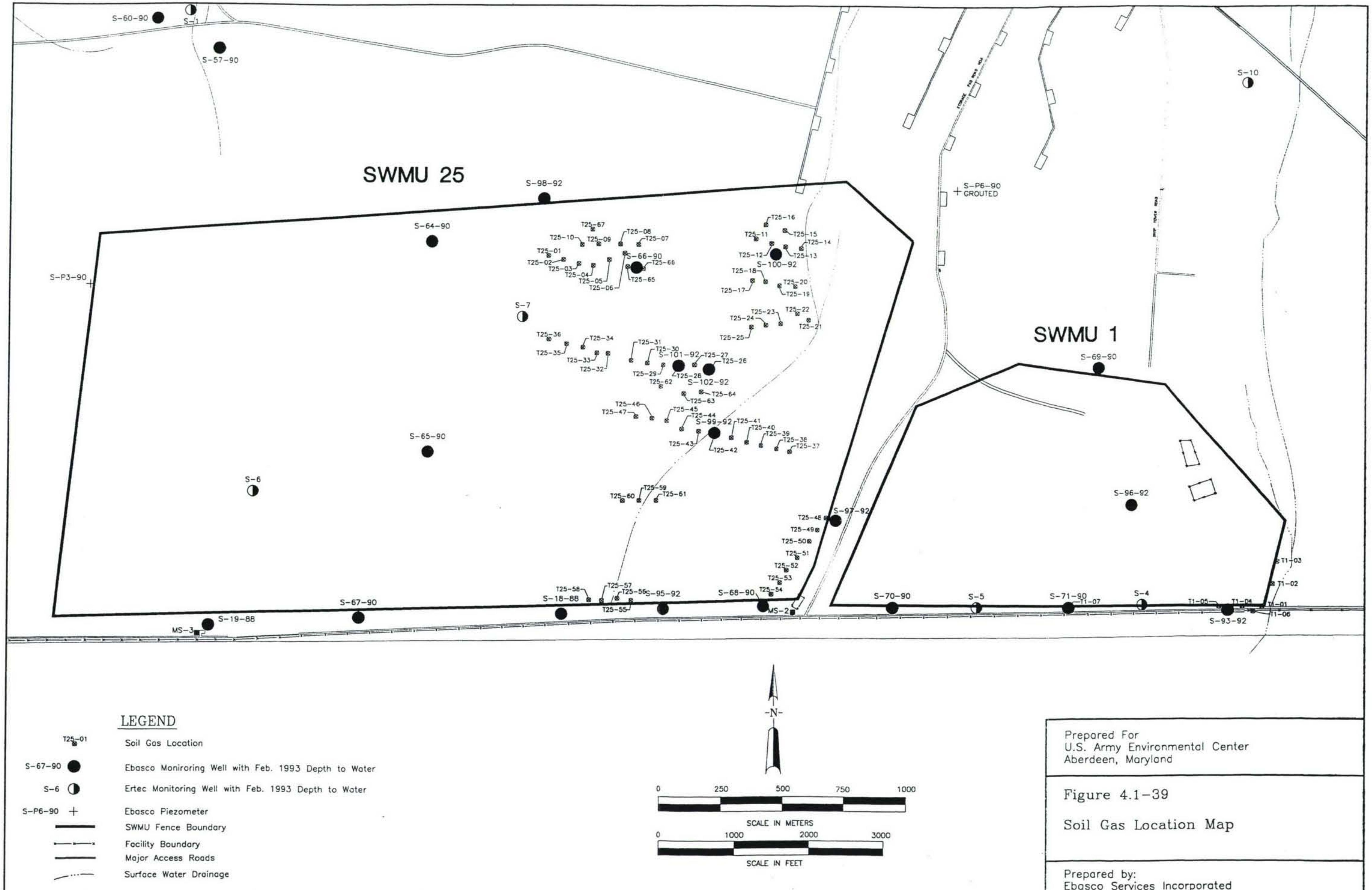

Figure 4.1-39

Soil Gas Location Map

undetectable, and in the northern areas, contaminants appear at mid to low levels (below 1,000 ppb). Unknowns in some of the chromatograms may indicate the presence of petroleum fuel products. Results of the soil gas survey for SWMU 25 are presented in Table 4.1-10.

At SWMU 1, the survey was limited to one sweep outside the southeast corner of the SWMU. While the target analytes appear to be at low or nondetectable levels, several compounds indicative of petroleum fuel products are apparent in the chromatograms. The concentrations of these unknowns are highest in the southeastern corner of SWMU 1 and appear to decrease toward the north and west along the perimeter of the site. SWMU 1 soil gas survey results are presented in Table 4.1-11.

4.1.2.3 Groundwater Contamination Assessment

Previous Investigations

Between 1982 and 1988, groundwater samples were collected intermittently from the six monitoring wells that had been installed in the vicinity of SWMUs 1 and 25 prior to the RFI-Phase I. The purpose of this sampling was to determine potential releases and downgradient migration of contaminants associated with the demilitarization and disposal of munitions and chemical agents in this area. Monitoring wells S-6 and S-7 are located within SWMU 25, while wells S-4, S-5, S-18-88, and S-19-88 are situated along the southern border of SWMUs 1 and 25 at the installation boundary. These six wells were sampled for VOCs, SVOCs, explosives, ABPs, total and dissolved metals, anions, and radiological parameters.

As part of the RFI-Phase I, eight additional monitoring wells were installed in and around SWMUs 1 and 25. Three wells were installed at SWMU 1, including S-69-90 as an upgradient well and both S-70-90 and S-71-90 as downgradient wells along the southern boundary of TEAD-S. The five remaining monitoring wells were installed at SWMU 25, including upgradient well S-64-90, wells S-65-90 and S-66-90 south of the cratered area, and wells S-67-90 and S-68-90 along the southern boundary of TEAD-S. Samples collected from wells during the RFI-Phase I were also analyzed for VOCs, SVOCs, explosives, ABPs, total and dissolved metals, anions, and radiological parameters.

Appendix E contains previous groundwater analytical results as presented in tables and maps in the RFI-Phase I report. This appendix should be consulted for information pertaining to results of the RFI-Phase I investigation and studies prior to 1990.

Sample	Target Analyte Concentration*				
	Benzene	TCE	Toluene	PCE	Xylene
RL	25	50	25	50	50
T25-01	59	170	61	150	76
T25-02	LT	57	LT	113	LT
T25-01D	28	91	30	87	LT
T25-03	31	87	26	76	LT
T25-04	LT	51	LT	110	62
T25-05	49	160	55	140	LT
T25-06	LT	LT	33	65	310
T25-07	LT	LT	LT	55	170
T25-08	LT	LT	33	LT	73
T25-09	50	140	66	113	68
T25-10	30	47	65	65	94
T25-11	26	52	66	90	94
T25-12	97	130	350	310	910
T25-13	41	81	100	94	480
T25-12D	30	57	66	75	170
T25-14	31	53	110	83	170
T25-15	27	LT	96	55	140
T25-16	42	87	82	120	130
T25-17	LT	LT	LT	60	88
T25-18	32	85	33	110	83
T25-19	LT	65	LT	70	60
T25-20	LT	82	27	LT	LT
T25-21	34	91	84	64	190
T25-22	30	84	63	60	170
T25-23	26	72	88	56	200
T25-24	30	80	LT	50	64
T25-25	44	130	63	160	150
T25-25D	32	88	72	85	210
T25-26	LT	65	40	71	300

Notes:
* measured in parts per billion
RL = reporting limit
TCE = trichloroethylene
PCE = tetrachloroethylene (perchloroethylene)
LT = less than the reporting limit

Sample	Target Analyte Concentration*				
	Benzene	TCE	Toluene	PCE	Xylen(
RL	25	50	25	50	50
T25-27	25	90	50	110	180
T25-28	LT	LT	41	LT	230
T25-29	30	76	130	74	370
T25-30	34	100	70	98	140
T25-31	36	110	58	98	88
T25-32	LT	76	51	65	92
T25-33	LT	LT	LT	LT	LT
T25-34	LT	LT	LT	LT	LT
T25-34D	LT	LT	30	LT	67
T25-35	LT	LT	LT	LT	53
T25-36	LT	LT	34	LT	120
T25-37	LT	LT	LT	LT	LT
T25-38	LT	LT	LT	LT	LT
T25-39	LT	LT	LT	LT	LT
T25-40	LT	LT	LT	LT	69
T25-41	28	30	30	63	92
T25-42	LT	170	170	88	842
T25-42D	LT	42	42	65	85
T25-43	LT	LT	LT	LT	57
T25-44	LT	LT	LT	LT	LT
T25-45	LT	86	86	63	360
T25-45D	LT	LT	LT	LT	LT
T25-46	LT	LT	LT	LT	83
T25-47	LT	LT	LT	LT	52
T25-48	LT	LT	LT	69	LT
T25-49	LT	LT	LT	LT	LT
T25-50	LT	LT	LT	LT	LT
T25-51	LT	LT	LT	LT	LT
T25-52	LT	LT	LT	LT	LT

Notes:
* measured in parts per billion
RL = reporting limit
TCE = trichloroethylene
PCE = tetrachloroethylene (perchloroethylene)
LT = less than the reporting limit

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Sample	Target Analyte Concentration*				
	Benzene	TCE	Toluene	PCE	Xylene
RL	25	50	25	50	50
T25-53	LT	LT	LT	LT	LT
T25-54	LT	LT	LT	LT	LT
T25-54D	LT	LT	LT	LT	LT
T25-55	LT	LT	LT	LT	LT
T25-56	LT	LT	LT	LT	LT
T25-56D	LT	LT	LT	LT	LT
T25-57	LT	LT	LT	LT	LT
T25-58	LT	LT	LT	LT	LT
T25-59	LT	LT	LT	LT	LT
T25-60	LT	LT	LT	LT	LT
T25-61	LT	LT	LT	LT	LT
T25-62	LT	LT	LT	LT	LT
T25-63	LT	LT	LT	LT	LT
T25-64	LT	LT	LT	LT	LT
T25-65	LT	LT	LT	LT	LT
T25-66	LT	LT	LT	LT	LT
T25-67	LT	LT	34	LT	270

Notes:
* measured in parts per billion
RL = reporting limit
TCE = trichloroethylene
PCE = tetrachloroethylene (perchloroethylene)
LT = less than the reporting limit

Table 4.1-11 SWMU 1 Soil Gas Results

Sample	Target Analyte Concentration (ppb)				
	Benzene	TCE	Toluene	PCE	Xylene
RL	25	50	25	50	50
T1-01	LT	LT	LT	65	110
T1-02	LT	LT	LT	LT	100
T1-03	LT	LT	LT	LT	62
T1-04	LT	LT	41	LT	190
T1-04D	LT	LT	35	50	192
T1-05	LT	LT	LT	LT	110
T1-06	LT	LT	LT	LT	120
T1-07	LT	LT	LT	LT	60

PPB = part per billion
RL = reporting limit
TCE = trichloroethylene
PCE = tetrachloroethylene (perchloroethylene)
LT = less than the reporting limit

Organic compounds were detected in groundwater samples collected from monitoring wells S-4, S-5, S-6, S-7, S-18-88, and S-19-88 in 1987 and 1988 prior to the RFI-Phase I. These compounds included toluene, phthalates, IMPA, 2-methyl phenol, benzyl alcohol, 2,4-dinitrotoluene, and 2,4,6-trinitrotoluene. However, none of these compounds were detected in the same wells during the RFI-Phase I.

During the RFI-Phase I, organic compounds were detected in only three monitoring wells in SWMUs 1 and 25. The SWMU 1 detections included benzyl alcohol in well S-5 and RDX in well S-71-90. Only well S-66-90, downgradient of the windrows at SWMU 25, contained detectable levels of fuel-related organic compounds including 1,2-dimethyl benzene, 1,3-dimethyl benzene, benzene, toluene, and benzyl alcohol. Toluene and benzyl alcohol detections in downgradient wells at SWMU 1 suggested either a similar use of fuels for munitions burning in SWMU 1, or potential downgradient migration of these contaminants from SWMU 25.

During the RFI-Phase I, arsenic and selenium were detected in groundwater samples at elevated levels compared to data from previous investigations. Chromium was detected at elevated concentrations in groundwater samples collected prior to 1990, but not during the RFI-Phase I. Anion concentrations in samples collected from monitoring wells at SWMUs 1 and 25 were elevated, but are probably characteristic of the natural groundwater geochemistry in this area.

RFI-Phase II Results

To further evaluate sporadic detections of contaminants in previous sampling programs, additional groundwater monitoring wells were installed during the RFI-Phase II to evaluate whether significant contaminants related to munitions disposal are migrating to the groundwater system underlying SWMUs 1 and 25. The new wells were installed at the following locations:

- At the installation boundary where contaminants could be migrating off-post
- In the covered and open trench area of SWMU 1 where chemical agent munitions were decontaminated, burned with fuels, and buried
- Between SWMUs 1 and 25 (potentially upgradient from the SWMU 1 trenches and downgradient from the SWMU 25 trenches)
- Upgradient and downgradient from the windrows, ash mounds, and incendiary burning area, where incendiary cluster bombs were burned with fuels

Samples were collected from all of the wells in SWMUs 1 and 25 to evaluate contaminant migration from all potential source areas. The complete analytical results of this sampling can be found in Appendix F2. Detections are summarized in Tables 4.1-12 through 4.1-14 and are illustrated at the sampling locations in Figures 4.1-40 through 4.1-42.

Organic Compounds

Table 4.1-12 presents a summary of organic compounds detected in groundwater at SWMUs 1 and 25 during the RFI-Phase II. Figure 4.1-40 shows the analytical results for organic compounds detected in groundwater samples taken from wells at SWMUs 1 and 25.

Four of the seven monitoring wells within and around SWMU 1 had detections of organic compounds. Methylene chloride, chloroform, and toluene were found in monitoring well S-96-92, which is screened in a confined aquifer below the covered and open trenches in east-central SWMU 1. Methylene chloride was detected at downgradient monitoring wells S-71-90 and S-93-92 and bis(2-ethylhexyl)phthalate was detected in S-70-90 along the southern installation boundary. Organic compounds were not detected at downgradient monitoring wells S-4 and S-5 along the southern boundary or at upgradient monitoring well S-69-90 (Figure 4.1-40).

Ten of the 16 monitoring wells associated with SWMU 25 had detections of organic compounds. Methylene chloride, carbon tetrachloride, and chloroform were found in upgradient monitoring well in well S-99-92 and in well S-99-92 downgradient of the incendiary burn area. Monitoring wells S-100-92, S-101-92, and S-102-92, inside the incendiary burn area in the northeastern portion of SWMU 25 and upgradient well S-64-90, had detections of methylene chloride. Monitoring well S-66-90, situated to the southeast of the windrows area in the north-central portion of SWMU 25, had detections of propylbenzene, xylene, 2-6-dinitrotoluene, 2-methylnaphthalene, benzene, ethyl-3-methylbenzene, ethylbenzene, toluene, and naphthalene. These compounds may have been released to the groundwater through the use of fuels to aid in burning at the windrows. Monitoring well S-97-92, on the southeastern boundary of SWMU 25 near the covered trenches area, had a detection of methylene chloride. Methylene chloride was not detected in groundwater samples collected from wells in SWMUs 1 and 25 during the RFI-Phase I, thus, it is likely that this compound can be attributed to laboratory contamination during Phase II monitoring. The sample from monitoring well S-19-88 on the southern boundary of SWMU 25 had detections of 1,1,1-trichloroethane and chloroform. Monitoring well S-95-92 had detections of 1,2-epoxycyclohexane and methylene chloride. Samples from six monitoring wells at SWMU 25 did not contain detectable levels of organics. These included S-18-88, S-67-90,

Table 4.1-12 Organic Compounds Detected in Groundwater at SWMUs 1 and 25

Analyte	Number of Samples	Number of Detections	Percent Detections	Minimum Concentration (µg/l)	Maximum Concentration (µg/l)
111TCE	23	1	4	ND	2.4
12EPCH*	2	2	100	4.0	4.0
26DNT	46	1	2	ND	0.111
2MNAP	23	1	4	ND	4.0
C6H6	23	1	4	ND	5.5
B2EHP	23	1	4	ND	4.4
CCL4	23	2	9	ND	50
CHCL3	23	4	17	ND	0.95
ETC6H5	24	2	8	ND	16
ET3MBZ*	1	1	100	30	30
CH2CL2	23	11	48	ND	500
NAP	23	1	4	ND	5.9
PRC6H5*	1	1	100	7	7.0
MEC6H5	23	2	9	ND	22
XYLEN	23	1	4	ND	79

Notes:
Please see Chemical Acronym List for acronym definitions.
* - Nontarget analyte
ND - Not detected

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Table 4.1-13 Dissolved Metals Detected in Groundwater at SWMUs 1 and 25

Analyte	Number of Samples	Number of Detections	Percent Detections	Site Minimum Concentration (µg/l)	Site Maximum Concentration (µg/l)	Background Concentration Range (µg/l)*
Sb	23	18	78	ND	177	ND - 65.8
As	23	22	96	ND	480	ND - 420
Ba	23	23	100	5.91	73.5	ND
Cr	23	1	4	ND	11.7	ND - 9.26
Cu	23	4	17	ND	12	ND - 52.4
Pb	23	6	26	ND	2.93	ND - 39.0
Se	23	14	61	ND	190	ND - 13.1
Tl	23	10	44	ND	132	ND
V	23	16	70	ND	55.45	NA**
Zn	23	4	17	ND	623	ND(21.1) - 1400

Note: The following dissolved metals were not detected in groundwater during the RFI-Phase II: beryllium, cadmium, cobalt, mercury, nickel, and silver. Concentrations are in micrograms per liter (µg/l).

* - Background data assembled from filtered analyses from Wells S-20-88, S-21-88, S-69-90, S-12, and S-22-88 at TEAD-S from 1982 through 1990.

** - Vanadium was not analyzed for in background groundwater samples except in samples from one well. These results did not yield detections of vanadium.

ND - Not Detected (detection limit)

NA - Not Analyzed

Please see Chemical Acronym List for acronym definitions.

See previous comment 37, your explanation concerning why the "Number of Samples" vary from one analyte to the next was good in the resp to comments, recommend adding it as a foot note to the table.

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Table 4.1-14 Anions Detected in Groundwater at SWMUs 1 and 25

Analyte	Number of Samples	Number of Detections	Percent Detections	Site Minimum Concentration (µg/l)	Site Maximum Concentration (µg/l)	Background Concentration Range (µg/l)*
Br	23	22	96	ND	13,000	ND - 20,000
Cl	23	23	100	530,000	15,000,000	580,000 - 36,000,000
F	23	23	100	1230	15,000	ND - 2600
HCO_3	23	23	100	105,000	856,000	NA
NIT	23	21	96	ND	560,000	ND - 11,400
SO_4	23	23	100	640,000	5,300,000	ND - 8,100,000

Note: Cyanide was not detected in groundwater. Concentrations are in micrograms per liter (µg/l)
* Background data assembled from wells S-SBR-1, S-20-88, S-21-88, S-69-90, S-12, and S-22-88 at TEAD-S from 1982 through 1990.
ND Not detected
NA Not analyzed

Please see Chemical Acronym List for acronym definitions.

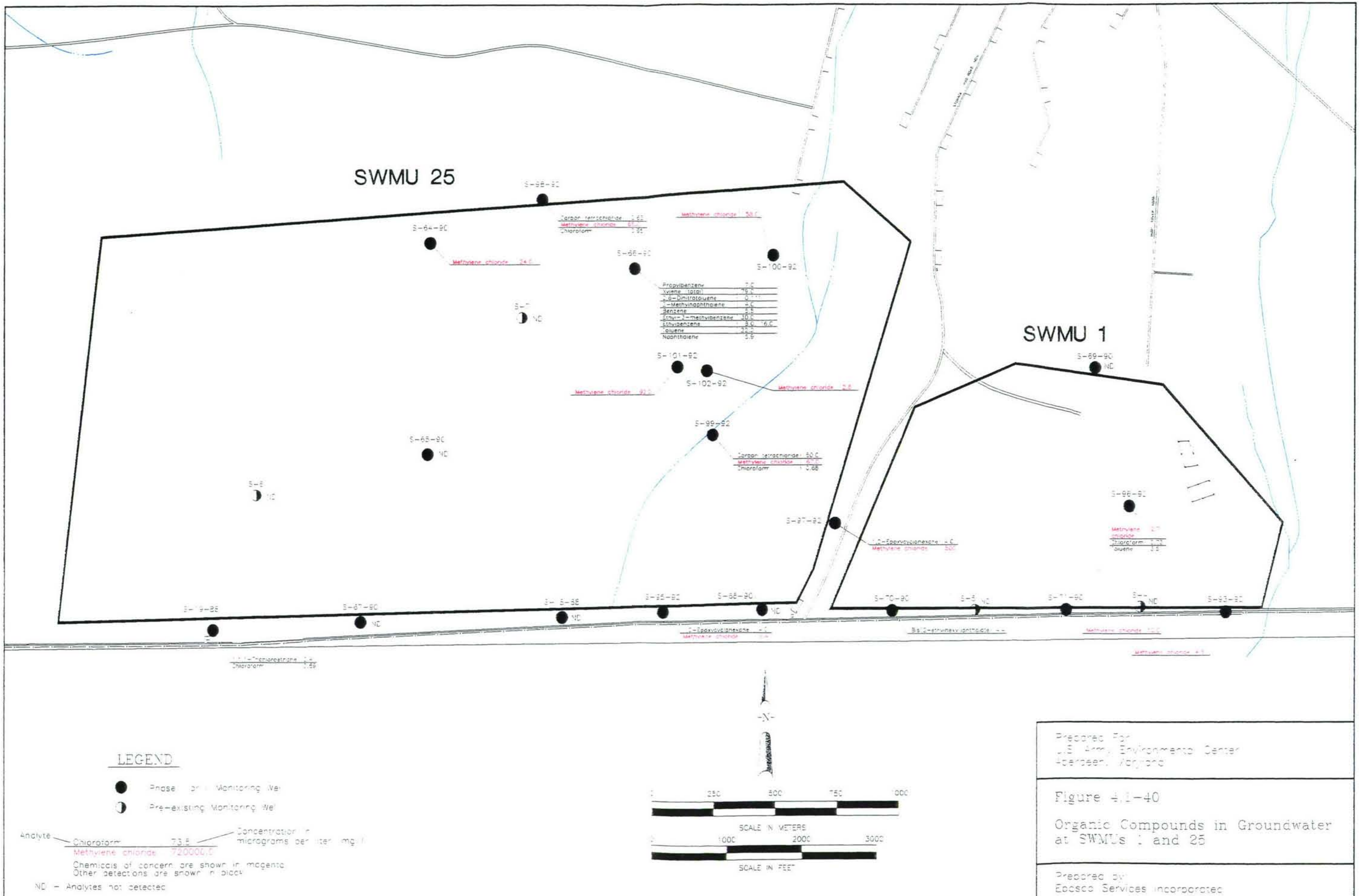


Figure 4.1-40

Organic Compounds in Groundwater at SWMUs 1 and 25

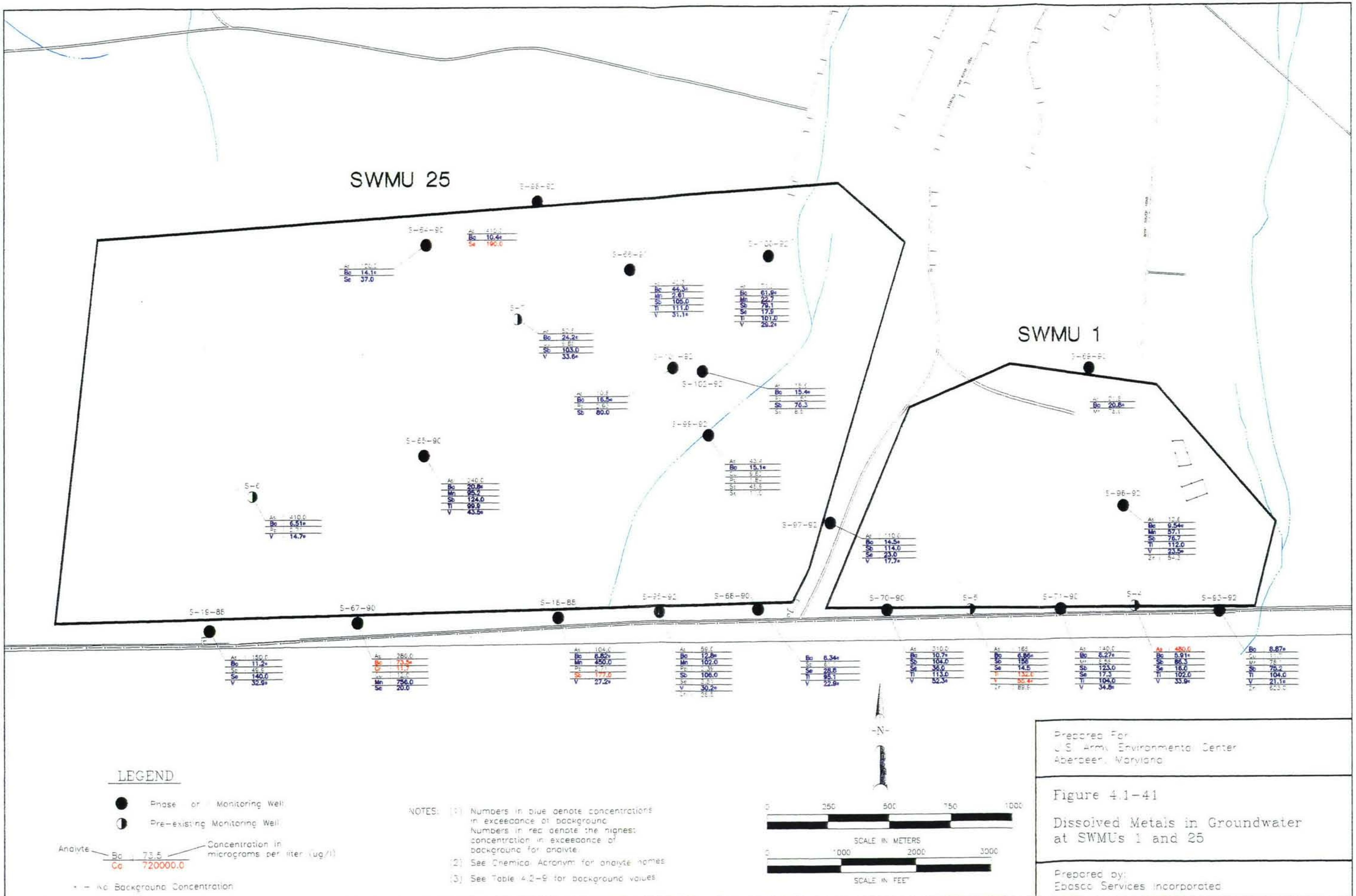
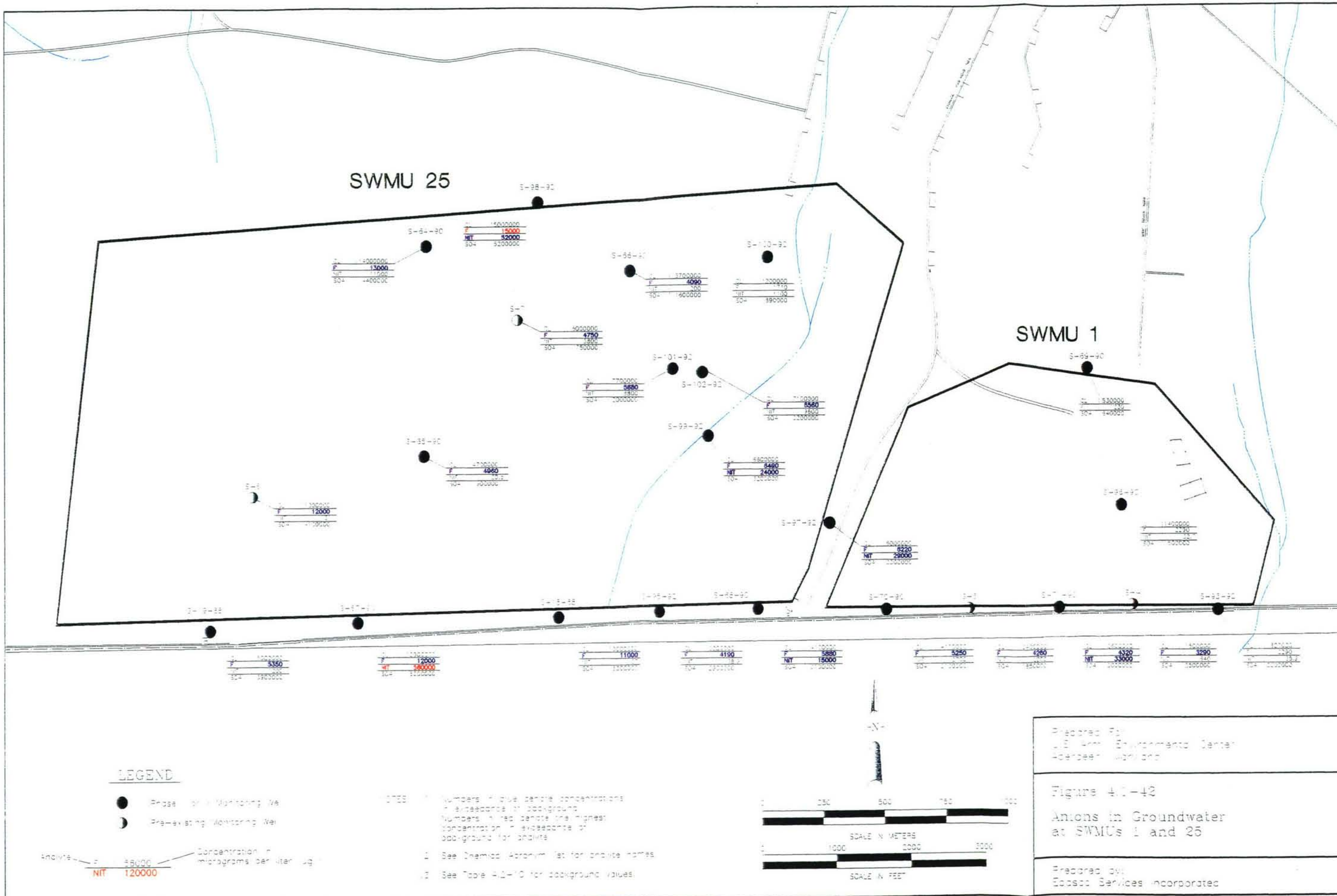


Figure 4.1-41

Dissolved Metals in Groundwater at SWMUs 1 and 25



Prepared by:
Ecosat Services Incorporated

Figure 4.2-42
Anions in Groundwater at SWMUs 1 and 25

and S-68-90 along the southern boundary and S-6, S-7, and S-65-90 within the high explosive craters area of SWMU 25 (Figure 4.1-40).

Metals

During the RFI-Phase II, groundwater samples were collected and analyzed for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. A summary of results for these analyses are presented in Table 4.1-13 and illustrated in Figure 4.1-41. All results reflect filtered concentrations. Metal concentrations for the RFI-Phase II were compared to TEAD-S background levels to determine the potential for groundwater contamination at SWMUs 1 and 25. Background levels for metals were discussed previously in Section 2.3.2.

Of the 15 metals analyzed during the RFI-Phase II, 5 were not detected in the 23 wells at SWMUs 1 and 25. These five metals include beryllium, cadmium, mercury, nickel, and silver. Chromium was detected only in the sample collected from well S-67-90 at a low concentration (11.7 µg/l). Of the detected metals, the following six occurred at levels above TEAD-S background: antimony, arsenic, barium, chromium, selenium, and thallium. Although these metals were detected above estimated background levels, there are no known sources of these metals that could be contributing to groundwater contamination in these areas.

Arsenic was detected in 22 wells, but was above background in only one (S-4). Antimony was greater than background in 15 wells. Since barium was analyzed for in only 1 background well, and not detected, background is tentatively defined as the detection limit. Barium was detected in all 23 wells, Chromium was greater than background in 1 well, selenium was greater than background in 11 wells, and thallium was greater than background in 10 wells. Background concentrations for vanadium at TEAD-S could not be established because of a lack of analytical data for this element in the background monitoring well database.

Arsenic concentrations varied from below the detection limit to a maximum concentration of 480 µg/l in well S-4. This maximum is only slightly above the background concentration of arsenic is 420 µg/l. Furthermore, arsenic concentrations exhibited no apparent spatial pattern or relationship to known contaminant sources. Since arsenic levels are commonly elevated in groundwater in basin-fill deposits of the western U.S. (Welch et al. 1988) and arsenic is mined commercially in the Mercur Creek area of the Oquirrh Mountains, which is located hydraulically and topographically upgradient of the site, a natural source for this element is likely.

Levels of antimony in groundwater ranged from below the detection limit to a maximum concentration of 177 µg/l (background is 65.8 µg/l). Detectable levels of antimony showed less variability than arsenic, but again demonstrated no apparent relationship to known contaminant sources at either SWMU. Nondetections occur in wells upgradient and downgradient of source areas. However, the RFI-Phase II levels are generally higher than levels encountered in previous investigations by an order of magnitude or more. This increase may indicate differences in sampling or analytical methodology. It seems unlikely that antimony is a contaminant that is leaching from waste sources to groundwater, as antimony was detected above background in only three soil samples. Antimony is mined in the Mercur Creek area, indicating that antimony at SWMUs 1 and 25 may be derived from mineralized sources in the Oquirrh Mountains.

Barium was detected in all wells within SWMUs 1 and 25. A potential source of barium may be the common mineral barite, $BaSO_4$. The average concentration of 18.1 µg/l in groundwater across the two SWMUs is within the range that would be expected if the concentration were controlled by barite solubility equilibria (Hem 1989). There are no known or suspected contaminant sources of barium at SWMUs 1 and 25.

Chromium was detected in one well at the site (S-67-90) at a concentration of 11.7 µg/l (background is 9.26 µg/l). It is probable, given the similarity between the background concentration and the detected concentration, that the chromium in well S-67-90 is of natural origin.

Selenium concentrations varied widely in SWMU 1 and 25 wells, ranging from below the detection limit to 190 µg/l in well S-98-92. RFI-Phase II concentrations were generally consistent with concentrations measured during previous sampling programs. Because there are no known or suspected sources of selenium at these SWMUs, these detections may reflect naturally occurring levels. High levels of selenium are known to occur in soil and groundwater of the western U.S., especially in semiarid to arid settings (Howard 1977; Rosenfeld and Beath 1964).

Thallium concentrations range from below the detection limit to a maximum of 132 µg/l in well S-5. It was detected in only 10 of the 23 wells at concentrations ranging from 95.1 µg/l to 132 µg/l. These levels are significantly greater than levels measured in previous sampling events. The differences between the RFI-Phase II results and previous results may be due to differences in sampling or analytical methodologies. The narrow range of detected concentrations and the

low correlation between soil and groundwater concentrations suggest that SWMUs 1 and 25 are not sources of thallium contamination in groundwater.

As part of the contamination assessment, metals concentrations in groundwater at SWMUs 1 and 25 were compared to groundwater geochemical trends identified in Section 2. Relationships between total dissolved solids (TDS) content, aquifer composition, well location and depth, and metal concentrations were examined. However, no single site characteristic or set of characteristics reliably explained the observed distribution and variability in groundwater metal concentrations.

Anions

Groundwater sampling at SWMUs 1 and 25 included analyses for the following seven anions: bromide, chloride, cyanide, fluoride, bicarbonate, nitrate/nitrite, and sulfate. Results of these analyses are presented in Table 4.1-14 and depicted on Figure 4.1-42. All results reflect unfiltered concentrations.

Of the seven analyzed anions, all but cyanide were detected in all 23 wells. These six analytes were compared to TEAD-S background concentrations to identify groundwater contamination. Where no background data were available, the levels were compared to State of Utah and federal maximum contaminant levels (MCLs) to determine if their levels exceeded health-based criteria. Table 2.3-4 lists the concentrations of anions detected in each well at SWMUs 1 and 25 and highlights the levels that exceed drinking water standards. Table 4.1-14 compares detected concentrations to TEAD-S background concentrations. Data on background levels of bicarbonate were not available.

As shown in Table 4.1-14, only fluoride and nitrate/nitrite exceeded TEAD-S background levels in groundwater. Fluoride exceeded background in 19 of 23 wells (background is 2600 μg/l). Fluoride levels exceeding background range from 3,290 μg/l to 15,000 μg/l. Wells not exceeding background are all located along the eastern portions of TEAD-S, where TDS levels are the lowest. Levels of nitrate/nitrite exceed background in 6 of 23 wells (background is 11,400 μg/l). Nitrate/nitrite levels exceeding background range from 15,000 μg/l to 560,000 μg/l. Wells exceeding background are widely scattered across SWMUs 1 and 25 and are separated by wells with levels below background.

Table 2.3-4 shows that some natural background analyte concentrations exceed state and federal drinking water standards. Analytes that exceed drinking water standards include chloride (23 of 23 wells), fluoride (23 wells), sulfate (19 wells), and nitrate/nitrite (6 wells). In addition to individual analytes, levels of TDS exceed state drinking water standards in all 23 wells. With the exception of nitrate/nitrite, which may be present in groundwater as breakdown products of explosive compounds, the anions in groundwater are very probably naturally occurring and represent groundwater quality that is naturally poor and nonpotable.

Comparison of RFI-Phase I and II Groundwater Assessment Results

Only six groundwater monitoring wells in and near SWMUs 1 and 25 have been sampled more than two times (wells S-4, S-5, S-6, S-7, S-18-88, and S-19-88). The data from these wells were evaluated for time-related concentration trends.

During RFI-Phase II sampling of this group of wells, organic compounds were detected only in well S-19-88. The two compounds detected, 1,1,1-trichloroethane and chloroform, were not detected in previous sampling programs. Metals concentrations in these wells were consistent with a few exceptions. One of the exceptions was antimony, which was an order of magnitude higher in the RFI-Phase II results. These results were reviewed by the laboratory, but no error or other explanation could be found. The other exception involved zinc concentrations ranging from 5 to 640 µg/l in well S-5. There was no consistent increase or decrease in the zinc concentrations over time in this well.

4.1.2.4 Air Contamination Assessment

During the RFI-Phase II investigation, ambient air sampling was conducted at sites located upwind and downwind of SWMU 1 and SWMU 25 as well as at a "background" site located near the southwest tip of Area 2. Target analytes included VOCs, SVOCs, selected metals, and total suspended particulates (TSPs). The samples were collected between August 10 and September 2, 1992. High-event monitoring criteria for the various parameters were used to select nine sampling days. Of the nine resulting sample sets, six were selected for analysis.

Organic Compounds

All VOCs analyzed were below detection limits with the exception of methylisobutyl ketone (MIBK). A concentration of 380 $\mu g/m^3$ was measured on August 14, 1992, at the SE site. This was measured downwind of SWMU 1 under north-northwest winds (Figure 4.1-43) suggesting that SWMU 1 could be a potential source of this contaminant. The inserts in Figure 4.1-43 show

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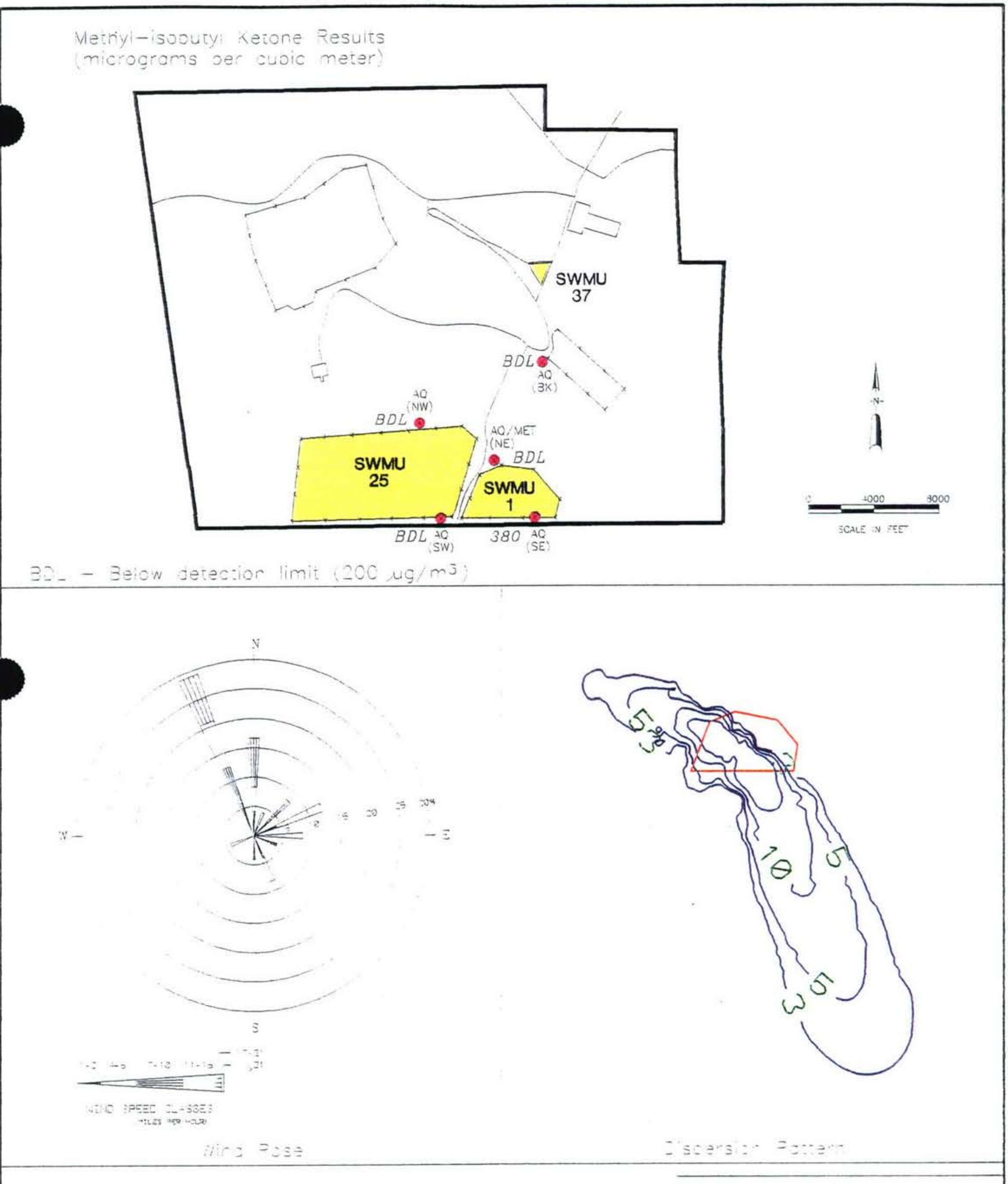

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 4.1-43
Methyl-isobutyl Ketone Results, Windrose, and X/Q Dispersion Pattern for August 14, 1992

Prepared by:
Ebasco Services Incorporated

the wind rose and dispersion patterns associated with this monitoring event. It is noted that MIBK was not detected at any of the other sampling sites on that day, or on any of the other five sampling days. As a preliminary screening evaluation, the maximum concentration is compared with the percent of threshold limit value-time-weighted average (TLV-TWA). The maximum MIBK value was less than 1 percent of the TLV-TWA criteria.

All SVOCs analyzed were below detection limits with the exception of di-n-butylphthalate (DNBP), which was measured at relatively uniform levels at all monitoring sites (Table 4.1-15). This compound is a component of some explosives and was also detected in two SWMU 25 soil samples; however, the detection of DNBP in field blanks also suggests a laboratory contamination source. The highest level of DNBP (214 $\mu g/m^3$) was measured at the background (BK) station.

Metals

The results of metals analyses are shown in Table 4.1-16. Ambient metal concentrations were below reporting limits with the exception of aluminum, arsenic, and sodium. Metals detected at concentrations below the laboratory-specified reporting limits are indicated with an asterisk. The widespread existence of naturally occurring sodium salts in near-surface soil may be the source for this element in air at the site. The maximum observed concentrations of aluminum and arsenic are 3.07 and 1.16 micrograms per cubic meter ($\mu g/m^3$), respectively. These values are less than 1 percent of the TLV-TWA criteria (10,000 and 200 $\mu g/m^3$, respectively).

Aluminum was measured on each sampling day and appeared to be uniformly distributed across the south-central portion of TEAD-S. Figure 4.1-44 shows the distributions of aluminum concentrations measured across SWMU 1 and SWMU 25 for the entire monitoring period. Since the average winds were primarily from the north-northwest, the wind dispersion pattern (Figure 4.1-44) suggests higher concentrations of site contaminants would be measured to the south-southeast of the SWMU. However, aluminum concentrations were actually slightly higher to the northwest indicating little likelihood that SWMUs 1 and 25 are significant sources of aluminum. Aluminum is a major component of clay minerals which are a likely natural source of the aluminum detected in air samples at the SWMUs.

There was one detection of arsenic. This detection occurred on August 14, 1992, at site SW in the southeast corner of SWMU 25. The 24-hour concentration was 1.16 $\mu g/m^3$. Figure 4.1-45 shows the distribution of arsenic levels measured on this date. The inserts again provide wind and dispersion patterns associated with this monitoring period. It appears from these results that

Table 4.1-15 Air Quality Results of Semivolatile Organic Compounds at TEAD-S

Date	Site ID	Di-n-butylphthalate (µg)	Di-n-butylphthalate (µg/m^3)
8/14/92	BK	12	31.5
8/14/92	Field Blank	41	NA
8/14/92	Field Blank	32	NA
8/14/92	Field Blank	23	NA
8/18/92	BK	110	214.0
8/18/92	NE	22	42.5
8/18/92	NW	27	56.6
8/18/92	SE	26	53.2
8/18/92	SW	25	47.8
8/20/92	BK	23	45.1
8/20/92	NE	17	33.2
8/20/92	NW	21	38.8
8/20/92	SE	20	41.4
8/20/92	SW	19	37.7
8/22/92	BK	49	91.8
8/22/92	NE	33	61.1
8/22/92	NW	45	85.4
8/22/92	SE	51	97.5
8/22/92	SW	40	75.1

Notes: No values above the detection limit were reported for any other target semivolatile organic analyte.

µg micrograms
µg/m^3 micrograms per cubic meter
NA not applicable

Table 4.1-16 Air Quality Results of Metals at TEAD-S

Date	Site ID	Aluminum ($\mu g/m^3$)	Arsenic ($\mu g/m^3$)	Barium ($\mu g/m^3$)	Chromium ($\mu g/m^3$)	Lead ($\mu g/m^3$)	Magnesium ($\mu g/m^3$)	Nickel ($\mu g/m^3$)	Sodium** ($\mu g/m^3$)	Zinc ($\mu g/m^3$)
8/14/92	BK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8/14/92	NW	3.07	BDL	BDL	BDL	0.05*	2.47*	BDL	BDL	BDL
8/14/92	SE	1.95*	BDL	BDL	BDL	BDL	1.51*	BDL	BDL	BDL
8/14/92	SW	1.46*	1.16	BDL	BDL	0.05*	BDL	BDL	BDL	BDL
8/14/92	NE	1.98*	BDL	BDL	BDL	0.06*	BDL	BDL	BDL	BDL
8/18/92	BK	1.39*	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.21*
8/18/92	NW	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.09*
8/18/92	NE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8/18/92	SW	1.34*	BDL	BDL	BDL	0.04*	1.25*	BDL	BDL	BDL
8/18/92	SE	BDL	BDL	BDL	BDL	0.04*	BDL	BDL	BDL	BDL
8/20/92	BK	1.25*	BDL	BDL	BDL	BDL	2.10*	BDL	BDL	BDL
8/20/92	NW	2.36	BDL	0.04*	BDL	0.06*	3.88*	BDL	11.36	0.56*
8/20/92	NE	3.07	BDL	BDL	BDL	BDL	3.70*	BDL	8.68	BDL

*	Denotes value obtained from analysis, falls below the certified reporting limit
**	Sodium concentrations shown here are blank corrected
BDL	Below detection limit
FBLK	Field blank, results in micrograms
TRIP	Trip blank, results in micrograms
$\mu g/m^3$	micrograms per cubic meter

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Table 4.1-16 Air Quality Results of Metals at TEAD-S

Date	Site ID	Aluminum ($\mu g/m^3$)	Arsenic ($\mu g/m^3$)	Barium ($\mu g/m^3$)	Chromium ($\mu g/m^3$)	Lead ($\mu g/m^3$)	Magnesium ($\mu g/m^3$)	Nickel ($\mu g/m^3$)	Sodium** ($\mu g/m^3$)	Zinc ($\mu g/m^3$)
8/20/92	SE	2.16	BDL	BDL	BDL	BDL	3.02*	BDL	13.08	BDL
8/20/92	SW	1.71*	BDL	BDL	BDL	BDL	2.45*	BDL	BDL	BDL
8/22/92	NW	2.21	BDL	BDL	BDL	BDL	2.59*	BDL	BDL	BDL
8/22/92	NE	3.02	BDL	BDL	BDL	0.05*	3.04*	BDL	BDL	BDL
8/22/92	SE	2.86	BDL	BDL	BDL	0.03*	3.62*	BDL	BDL	BDL
8/22/92	SW	2.73	BDL	BDL	BDL	BDL	2.23*	BDL	BDL	0.10*
8/27/92	BK	2.20*	BDL	0.87*	0.24*	BDL	2.28*	BDL	BDL	0.09*
8/29/92	BK	2.28	BDL	0.07*	0.18*	BDL	2.07*	BDL	BDL	0.09*
8/29/92	NW	2.89	BDL	0.10*	BDL	0.05*	2.99*	BDL	BDL	0.12*
8/29/92	NE	2.21	BDL	0.04*	BDL	0.06*	2.45*	BDL	BDL	0.12*
8/29/92	SE	2.17	0.04*	0.04*	BDL	BDL	2.58*	BDL	BDL	0.07*
8/29/92	SW	1.21*	BDL	BDL	BDL	1.24*	BDL	BDL	BDL	0.23*

* Denotes value obtained from analysis, falls below the certified reporting limit
** Sodium concentrations shown here are blank corrected
BDL Below detection limit
FBLK Field blank, results in micrograms
TRIP Trip blank, results in micrograms
$\mu g/m^3$ micrograms per cubic meter

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Table 4.1-16 Air Quality Results of Metals at TEAD-S

Date	Site ID	Aluminum ($\mu g/m^3$)	Arsenic ($\mu g/m^3$)	Barium ($\mu g/m^3$)	Chromium ($\mu g/m^3$)	Lead ($\mu g/m^3$)	Magnesium ($\mu g/m^3$)	Nickel ($\mu g/m^3$)	Sodium** ($\mu g/m^3$)	Zinc ($\mu g/m^3$)
8/31/92	BK	2.96	0.05*	BDL	BDL	BDL	2.61*	BDL	BDL	0.08*
8/31/92	NW	2.94	BDL	0.04*	BDL	BDL	3.39*	BDL	BDL	BDL
8/31/92	NE	2.29	BDL	BDL	BDL	BDL	2.21*	BDL	BDL	BDL
8/31/92	SE	2.40	BDL	0.05*	BDL	BDL	3.88*	BDL	BDL	0.09*
8/31/92	SW	1.99*	BDL	BDL	BDL	BDL	2.14*	BDL	BDL	BDL
8/14/92	FBLK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	213	BDL
8/18/92	FBLK	BDL	BDL	BDL	BDL	0.40*	BDL	BDL	204	BDL
8/20/92	FBLK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	213	BDL
8/22/92	FBLK	19.9*	BDL	BDL	BDL	BDL	16.0*	BDL	183	4.2*
8/29/92	TRIP	BDL	BDL	BDL	BDL	BDL	BDL	BDL	179	BDL
8/31/92	TRIP	BDL	BDL	BDL	BDL	BDL	BDL	BDL	181	BDL

* Denotes value obtained from analysis, falls below the certified reporting limit
** Sodium concentrations shown here are blank corrected
BDL Below detection limit
FBLK Field blank, results in micrograms
TRIP Trip blank, results in micrograms
$\mu g/m^3$ micrograms per cubic meter

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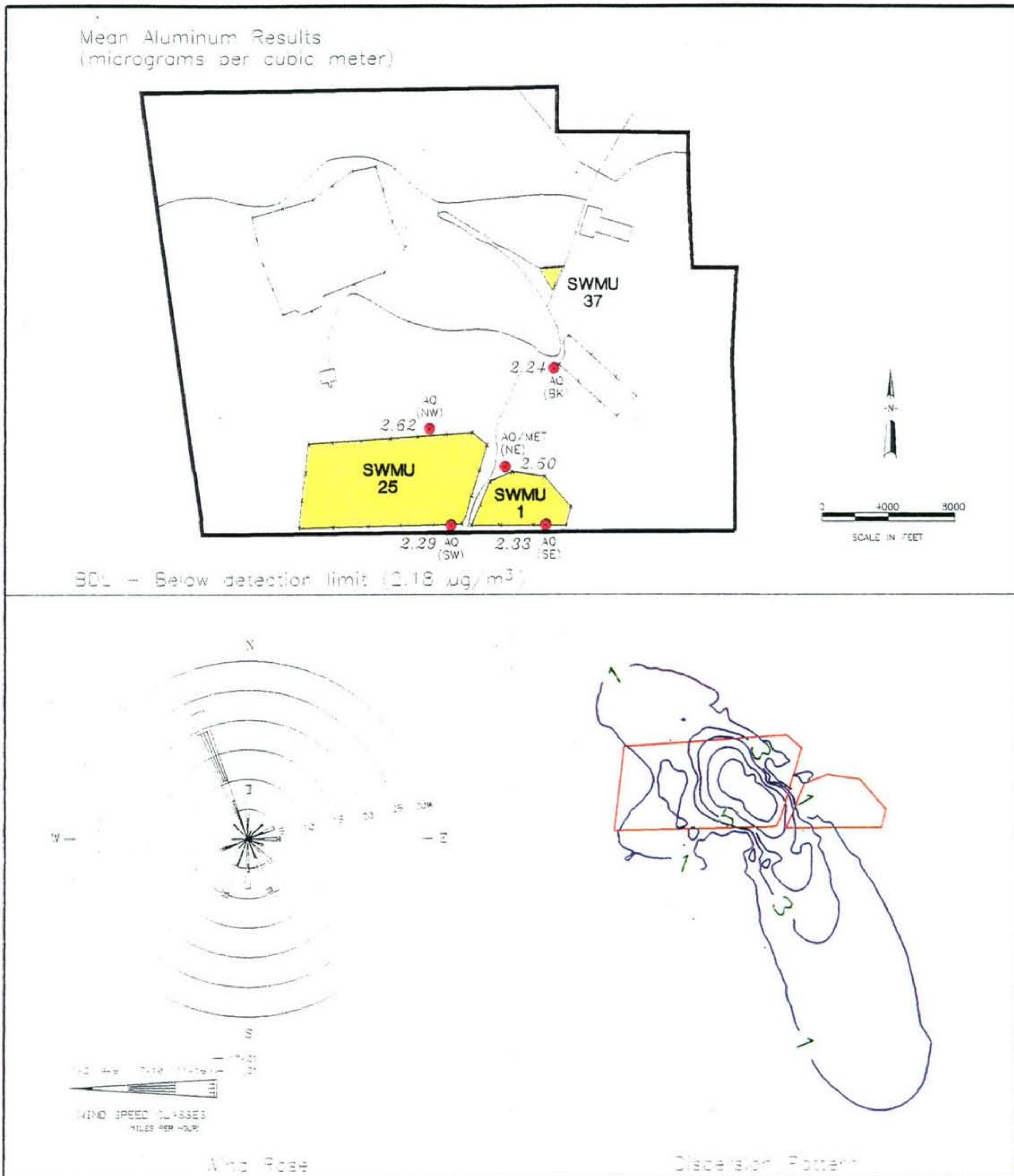

Prepared for:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 4.1-44

Mean Aluminum Results, Windrose, and K.Q Dispersion Pattern for August 14, 1992 - August 31, 1992

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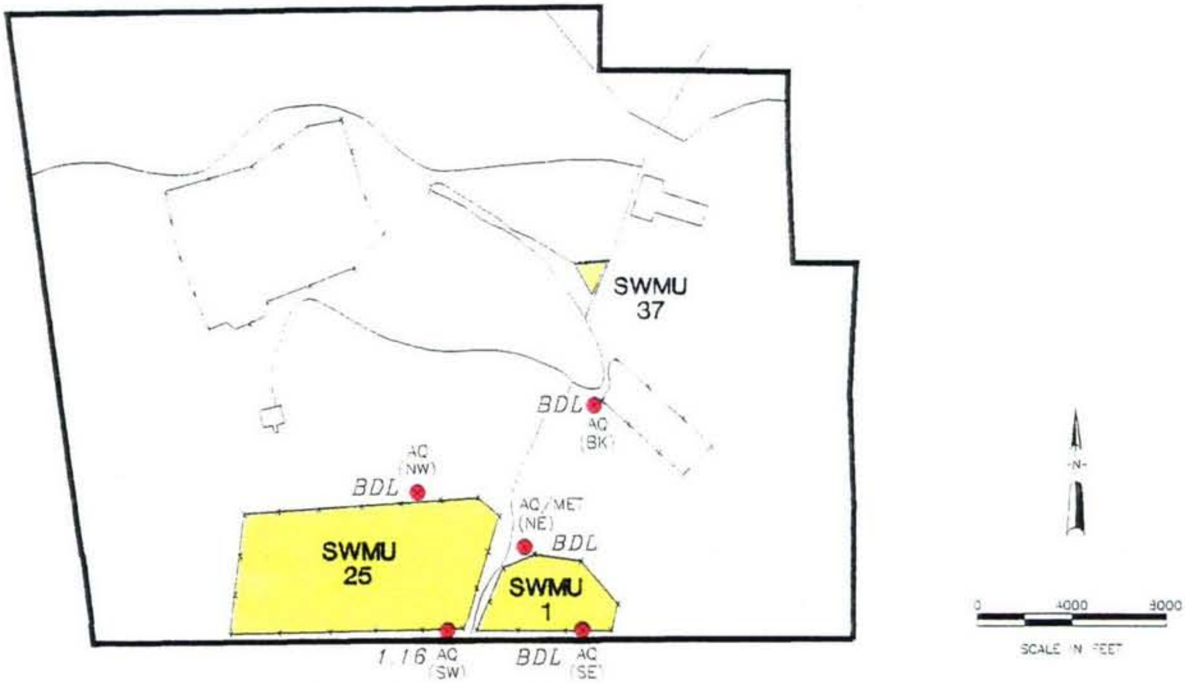
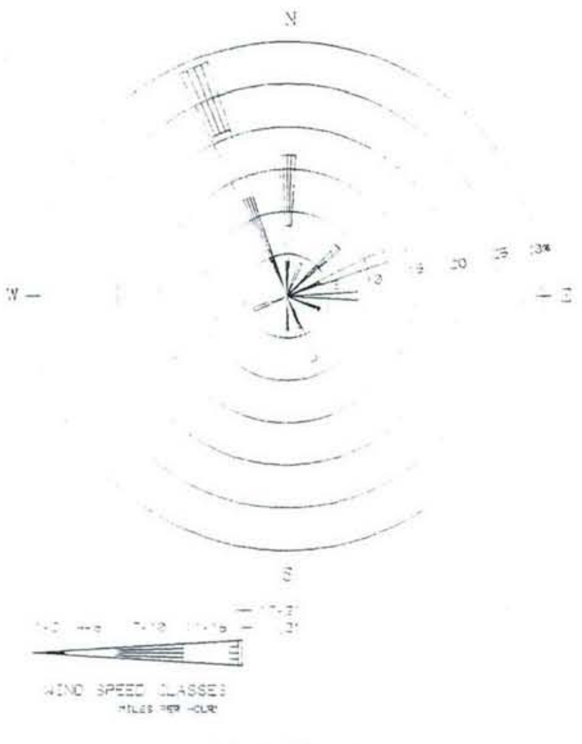
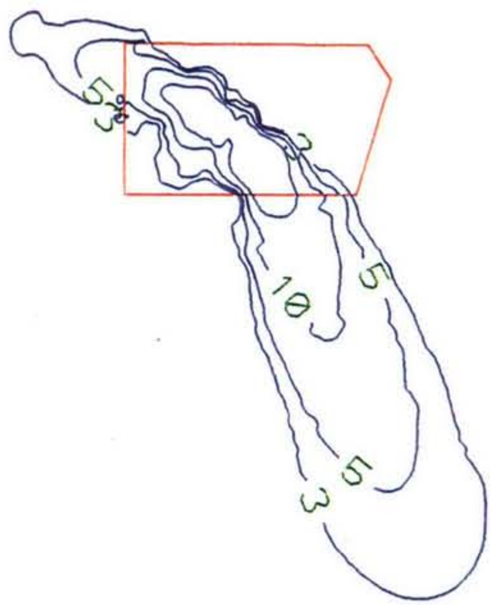
Arsenic Results
(micrograms per cubic meter)



BDL - Below detection limit (0.180 μg/m³)



Wind Rose



Dispersion Pattern

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Aberdeen, Maryland

Figure 4.1-45
Arsenic Results, Windrose, and X/Q Dispersion Pattern for August 14, 1992

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SWMU 25 may be a potential source of arsenic. Arsenic was also measured at lower concentrations (below the laboratory reporting limit) at sites SE and BK on two separate occasions. However, arsenic is known to occur at naturally high levels in desert soils in the western United States, so low levels of the metal in the general area are not unexpected.

Sodium was detected in all sampling filters on all sampling days. However, significant levels of sodium were measured in the field and trip blank filters for each of the monitoring periods, suggesting that sodium is a contaminant in the filter. As the blank levels were consistent, a standard protocol was employed of subtracting the field blank value from the monitoring sample value. The net ambient concentrations of sodium measured are shown in Table 4.1-16. It appears from the data that sodium levels occur above detection limits in the TEAD-S area. However, because of contamination in the filters, results are inconclusive to assess sodium levels quantitatively either in the SWMU areas or the general area at TEAD-S. Future investigations will include the use of sodium-free filters if sodium concentrations become an issue.

Total Suspended Particulates

TSP is a by-product of the metals analyses, as metals samples were collected on low volume samplers. The low flow rate (one-hundredth of the typical high-volume sampler rates) was unsuitable for calculating precise quantitative values for comparison with ambient standards using standard techniques of gravimetric determination. Qualitatively, results indicated an even distribution of TSP levels across the south-central portion of TEAD-S, with no special source of TSP over either of the SWMU areas. Historical data at TEAD-S show no special concern with TSP.

At present, only PM-10 is measured routinely at TEAD-S. Samples were collected routinely (every 6 days) at four sites during the August 1992 monitoring program. PM-10 levels ranged from a low of 16 μg/m^3 to a high of 58 μg/m^3. These compare well with the 24-hour National Ambient Air Quality Standard (NAAQS) of 150 μg/m^3. Only one day of this program (August 22) was concurrent with the RFI-Phase II high-event monitoring program. It is interesting that the highest PM-10 levels during the month were also collected on this date. On this date TSP levels ranged from 145 μg/m^3 to 214 μg/m^3. Although these TSP data are too imprecise to validate them, they are consistent with the high PM-10 levels reported.

Summary
In summary, air monitoring sample results indicate that SWMU 1 and SWMU 25 are not critical sources of toxic contaminants in air. Out of 39 target VOCs, only MIBK was detected on one day at SWMU 1. The level measured was less than 1 percent of the human health risk-based criteria.

All SVOCs were below detection limits with the exception of di-n-butylphthalate (DNBP). The presence of this compound at uniform levels at the monitoring sites surrounding SWMUs 1 and 25 and in all field blanks suggests that this analyte was introduced by a laboratory or other contamination source not associated with SWMUs 1 and 25. A higher level of DNBP (214 $\mu g/m^3$) measured at the background station (BK) may also be the result of sample contamination; however, further investigation of this compound as a potential contamination may be warranted, particularly in light of high explosives detonation at SWMU 31, adjacent to the east side of SWMU 1.

Of the metals, arsenic, aluminum, and sodium were measured above laboratory reporting limits. Several other metals were reported at lower levels. Arsenic was also measured at lower levels at several locations near the SWMU 1 and SWMU 25 areas. Aluminum and sodium appear to be widespread across TEAD-S and are probably derived from natural sources in surface soils. Levels measured were well below health risk-based criteria.

This air monitoring program was a screening effort only. It was designed to collect a small number of samples over a short time period using cost-effective sampling equipment in the absence of a power line. More sensitive sampling and analysis methods can yield lower detections limits for parameters of concern if such analyses are required.

4.1.3 Contaminant Fate and Transport
An understanding of the factors controlling the environmental fate and transport of contaminants at SWMUs 1 and 25 is essential to determine the potential for both on- and off-post migration, as well as to assess the potential risk of current and future exposure to these compounds in environmental media.

This section evaluates the potential routes of migration at SWMUs 1 and 25, discusses the physical and chemical characteristics of site contaminants, and identifies the potential for on-post and off-post contaminant migration. The physical characteristics of environmental media at

SWMUs 1 and 25 were described in Sections 2.0 and 4.1.1, and the types, concentrations, and areal extent of contamination were described in Section 4.1.2.

4.1.3.1 Potential Migration Routes

Chemical and other munitions detonation, burning, and other disposal at SWMUs 1 and 25 may have contributed to contamination of surface and subsurface soil and groundwater at both SWMUs.

A conceptual model of the potential fate and transport processes operating at SWMUs 1 and 25 is displayed in schematic form in Figure 4.1-46. This figure illustrates the sources, potential release mechanisms and transport processes, transport media, and potential fate processes operating at the site. The release and transport of contaminants from the individual source locations within SWMUs 1 and 25 result in varying degrees of on- and off-post migration, the magnitude of which is dependent upon the type of transport process and medium and the susceptibility of each source area to the release mechanism.

Contaminant sources at SWMUs 1 and 25 include numerous waste disposal areas including the explosion craters, ash mounds, incendiary burn area, windrows, and covered and open trenches. Migration of wastes from these sources has resulted in varying degrees of contamination of surface and subsurface soil and groundwater at each SWMU.

As shown in Figure 4.1-46, contaminants presently exposed in surface soil may be mobilized by surface transport processes including wind erosion, volatilization, or episodic overland water flow. Contaminants from these sources may also leach or desorb to subsurface soils and potentially contaminate site groundwater.

If mobilized by surface-water runoff, contaminants may eventually re-enter the subsurface environment by infiltration. In the process of infiltration, contaminants may remain behind in surface soil, where attenuation by photolysis or biodegradation reactions may occur. Surface transport by overland flow to a standing body of water, such as Rush Lake, is also possible. Contaminants mobilized as fugitive dust can be deposited onto surface soil or surface water bodies or dispersed in local air masses.

Volatile contaminants in subsurface soil can volatilize to soil gas and migrate to the atmosphere, or migrate laterally within the unsaturated zone and eventually reach groundwater. Volatile

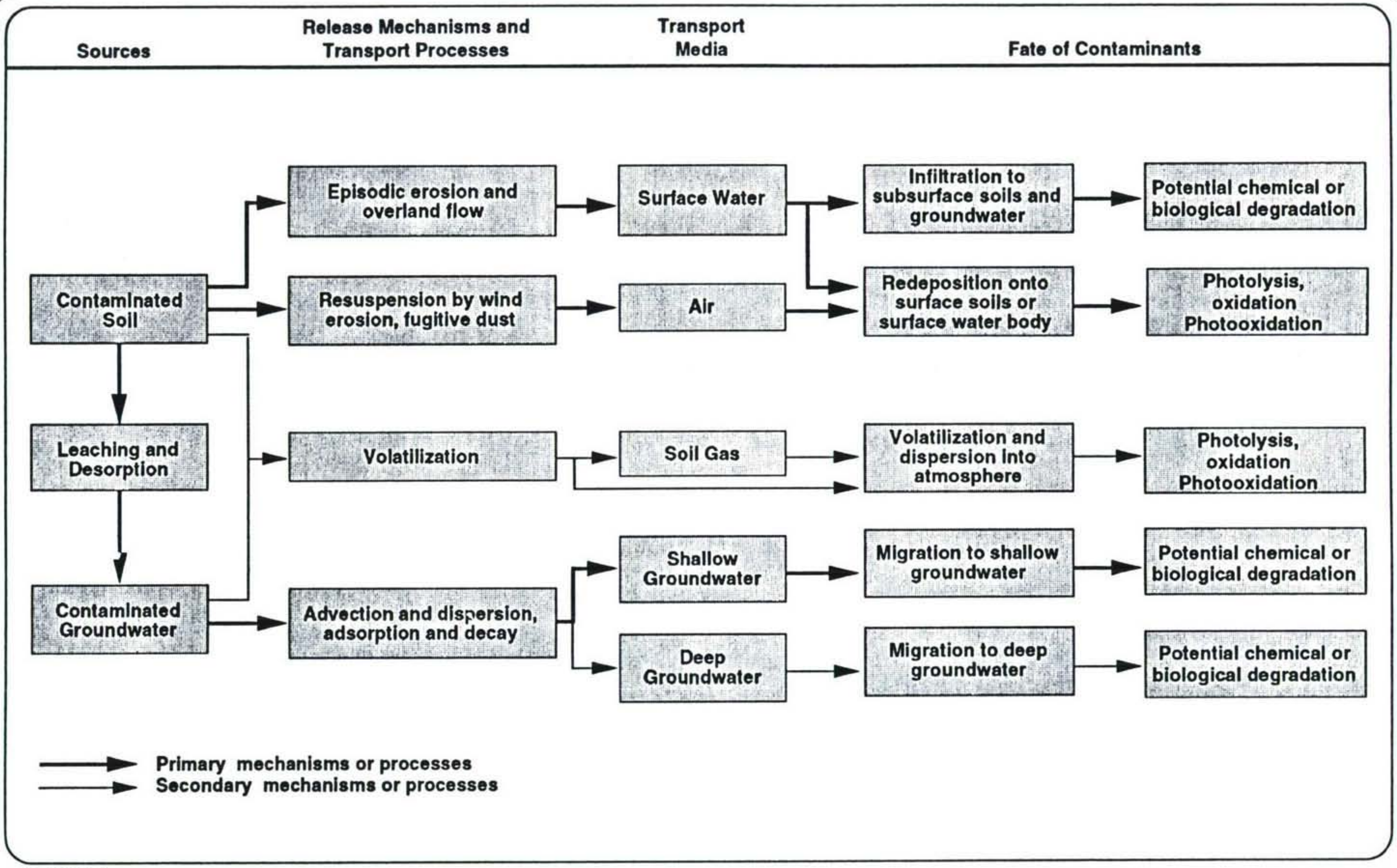

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Figure 4.1-46
Fate and Transport Conceptual Model
for SWMUs 1 and 25

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contaminants that migrate to the atmosphere are subject to dispersal by wind and attenuation by photolysis and photooxidation reactions. Dry and wet deposition from the atmosphere to surface soils or surface water bodies downwind of the site may also occur.

Contaminants that have migrated to groundwater are subject to further migration by advective flow and dispersion, adsorption to aquifer solids, or volatilization to soil gas. Transport by groundwater flow may further redistribute contaminants in the shallow groundwater environment or transfer them to deeper hydrostratigraphic units. Contaminants that remain in groundwater or soil are subject to attenuation by adsorption and by chemical and biological degradation processes.

4.1.3.2 Contaminant Mobility and Behavior

Contaminant mobility and behavior at SWMUs 1 and 25 are dependent upon the chemistry of the contaminant and the physical and chemical properties of site environmental media. The interaction between the two determines the fate and transport of the compound. Important organic contaminant properties include, but are not limited to, aqueous solubility, vapor pressure, Henry's law constant, octanol/water partition coefficient, density, and the half-life of the contaminant in various environmental media. Table 4.1-17 lists the values for these and other properties for each organic contaminant at SWMUs 1 and 25.

Organic contaminants detected in soil by the RFI-Phase II investigation consisted mainly of low levels of semivolatile phthalates and polynuclear aromatic hydrocarbons (PAHs), with lesser amounts of pesticides, pesticide breakdown products, and explosives.

Organic contaminants in groundwater consist mainly of low levels of VOCs that include BTEX compounds (benzene, toluene, ethylbenzene, xylenes) and chlorinated solvents (1,1,1-trichloroethane, methylene chloride, carbon tetrachloride, and chloroform). Explosives (2,6-dinitrotoluene), substituted benzenes (ethyl-3-methyl benzene) and naphthalenes were also detected. The metals antimony, arsenic, barium, chromium, selenium, and thallium may potentially be contaminants as well.

As shown in Table 4.1-17, the chemical properties of VOCs differ significantly from those of SVOCs. These differences are reflected in the environmental behavior of the VOCs. The most obvious differences are in the higher vapor pressures and aqueous solubilities of VOCs, making them more susceptible to migration by volatilization or dissolution and transport in surface water

Table 4.1-17 Physical and Chemical Properties of Organic Compounds in Soil and Groundwater at SWMUs 1 and 25

Compound	CAS No.	Formula	Molecular Weight (g/mol)	Physical State	Density (g/ml)	Aqueous Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Kow	Soil Half-Life*	Groundwater Half-Life*	Surface Water Half-Life*	Air (Photolysis or Photooxidation) Half-Life*
Volatile Organics													
1,1,1-Trichoroethane (G)	71-55-6	$C_2H_3Cl_3$	133.4	Liquid	1.35	1,500	123	0.0144	316	20-39wk	20-78wk	20-39wk	225 days-6.2yr
Chloroform (G)	67-66-3	$CHCl_3$	119.4	Liquid	1.49	8,200	151	0.00287	93.3	4wk-6mo	8wk-5yr	4wk-6mo	26-260 days
Carbon tetrachloride (G)	56-23-5	CCl_4	153.8	Liquid	1.59	757	90	0.0241	437	6mo-1yr	1wk-1yr	6mo-1yr	1.8-18.3yr
Methylene chloride (G)	75-09-2	CH_2Cl_2	84.9	Liquid	1.33	20,000	362	0.00203	20	1-4wk	2-8wk	1-4wk	19-191 days
Benzene (G)	71-43-2	C_6H_6	78.11	Liquid	0.878	1,791	95.19	0.0054	135	5-16 days	10 days-24mo	5-16 days	2-21 days
Ethylbenzene (G)	100-41-4	C_8H_{10}	106.16	Liquid	0.867	161	9.53	0.0084	1412	3-10 days	6-228 days	3-10 days	3.6 days
Toluene (G)	108-88-3	C_7H_8	92.13	Liquid	0.866	535	28.4	0.0059	537	4-22 days	1-4wk	4-22 days	4.3 days
Xylenes, total (G)	1330-20-7	C_8H_{10}	106.16	Liquid	0.864	159	7.8	0.0068	1438	1-4wk	2wk-12mo	1-4 wk	1.8 days
Propylbenzene (G)	103-65-1	C_9H_{12}	120.19	Liquid	0.862	23.4	2.5	0.01021	4786	No data	No data	No data	No data
Semi-Volatile Organics													
2-Methylnapthalene (G)	91-57-6	$C_{11}H_{10}$	142.2	Solid	1.006	26	0.068	0.0005	7,244	No data	No data	2.25 day	7hr-28 days
Ethyl-3-methyl benzene (G)	620-14-4	C_9H_{12}	120	Liquid	.864	Insoluble	No data	No data	No data	No data	No data	No data	No data
Bis(2-ethylhexyl)phthalate (S,G)	117-81-7	$C_{24}H_{38}O_4$	390.54	Liquid	0.986	0.285	2×10^{-7}	0.00001	128,825	5-23 days	10-389 days	5-23 days	3-29 hr
2-6-Dinitrotoluene (G)	606-20-2	$C_7H_6N_2O_4$	182.14	Solid	1.38	270	0.0051	8.7×10^{-7}	95.5	4wk-6mo	2 day-12 mo	2-17 hr	17-25 hr
Acenaphthene (S)	83-32-9	$C_{12}H_{10}$	154.2	Solid	1.024	3.42	10 (132°C)	0.006	8318	12-102 days	25-204 days	12.5 days	1-9 hr
Benzo(a)anthracene (S)	56-55-3	$C_{18}H_{12}$	228.3	Solid	NA	0.014	$5 X 10^{-9}$	NA	407,380	102 days-2yr	204 days-3.7 yr	1-3 hr	1-3 hr
Benzo(k)fluoranthene (S)	207-08-9	$C_{20}H_{12}$	252.3	Solid	NA	0.00076	9.6×10^{-11}	1.7×10^{-6}	3.7×10^6	2.5-6yr	5-12 yr	4-500 hr	1-11 hr
Fluoranthene (S)	206-44-0	$C_{16}H_{10}$	202.3	Solid	1.25	0.265	NA	2.71×10^{-4}	213,796	140-440 days	280 days-2.4yr	2.6 days	2-20 hr
Pyrene (S)	129-00-0	$C_{16}H_{10}$	202.3	Solid	1.27	0.16	6.85×10^{-7}	2.13×10^{-4}	151,356	210 days-5.2 yr	1.2-10.4 yr	1-2 hr	1-2 hr

Table 4.1-17 Physical and Chemical Properties of Organic Compounds in Soil and Groundwater at SWMUs 1 and 25

Compound	CAS No.	Formula	Molecular Weight (g/mol)	Physical State	Density (g/ml)	Aqueous Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Kow	Soil Half-Life*	Groundwater Half-Life*	Surface Water Half-Life*	Air (Photolysis or Photooxidation) Half-Life*
Chrysene (S)	218-01-9	$C_{18}H_{12}$	228.3	Solid	1.27	0.003	6.3×10^{-7}	9.4×10^{-8}	407,380	1-2.7 yr	2-5.5y	4-13 hr	1-8 hr
Naphthalene (S)	91-20-3	$C_{10}H_8$	128.2	Solid	1.03	30	0.082	2.01×10^{-2}	2,344	16.6-48 days	258 days	12-480 hr	3-30 hr
Phenanthrene (S)	85-01-8	$C_{14}H_{10}$	178.2	Solid	0.98	0.816	1.0	1.64×10^{-3}	28,840	16-200 days	32 days-1.1 yr	3-25 hr	2-20 hr
1,2-Epoxycylcohexane (S)	286-20-4	$C_6H_{10}O$	98.16	Liquid	0.967	Insoluble	No data	No data	No data	No data	No data	No data	No data
Di-n-butyl phthalate (S)	84-74-2	$C_{16}H_{22}O_4$	278.34	Liquid	1.046	11.2	1.4×10^{-5}	4.6×10^{-7}	52,481	2-23 days	2-23 days	1-14 days	3.1 days
Tetryl (S)	479-45-8	$C_7H_5N_5O_8$	287.15	Solid	1.57	57.4	$< 1 \times 10^{-8}$	1.0×10^{-11}	109.7	No data	No data	305 Days	30 Days
Hexachlorobenzene (S)	118-74-1	C_6Cl_6	284.8	Solid	1.57	0.035	1×10^{-5}	0.0013	295,121	2.7-5.7 yr	5.3-11.4 yr	2.7-5.7 yr	156 days-4.2 yr
Dithiane (S)	505-23-7	$C_4H_8S_2$	120	Solid	No data	3,000	.80	NA	5.89	No data	No data	No data	No data
Pesticides													
p,p-DDD (S)	72-54-8	$C_{14}H_{10}Cl_4$	320.05	Solid	1.385	0.02	1×10^{-6}	0.016	977,237	2-15.6 yr	70 days-31.3 yr	2-15.6 yr	7.4 days
p,p-DDE (S)	72-55-9	$C_{14}H_8Cl_4$	318.0	Solid	No data	0.065	6.5×10^{-6}	No data	489,779	2-15.6 yr	16 days-31.3 yr	6.1 days	7.4 days
p,p-DDT (S)	50-29-3	$C_{14}H_9Cl_5$	354.5	Solid	No data	0.0055	1.9×10^{-7}	0.0123	1.5×10^6	57 days-1.5 yr	114 days-2.9 yr	0.4-1.1 hr	0.4-1.1 hr
Other													
Fluoroacetic acid (S) (Pka = 2.66)	144-49-0	$C_2H_3FO_2$	78.04	Solid	1.37	1.32×10^5	1.9	No data	0.87	No data	No data	No data	No data

(G) Groundwater contaminant
(S) Soil contaminant
* Half-life data primarily from "Handbook of Environmental Degradation Rates" (Howard et al. 1991), and secondarily from Hazardous Substance data Base - Tommes data Base (Micromedex, Inc. 1994).
Physical and chemical properties from "Handbook of Environmental Fate and Exposure data" (Howard 1989, 1990), "Groundwater Chemicals Desk Reference, Vols. 1 and 2 (Montgomery and Welkom, 1989; Montgomery, 1991), and the Hazardous Substance data Base - Tomes data Base (Micromedex, Inc. 1994)

g/mol	- grams per mole	atm-m^3/mol	- Atmospheres per cubic meter per mole
mmHg	- millimeters mercury	hr	- hour
mg/l	- milligrams per liter	mo	- month
g/ml	- grams per milliliter	wk	- week
NA	- not applicable	yr	- year

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and groundwater than are the SVOCs. Compounds with high aqueous solubilities are generally more susceptible to biodegradation than less soluble compounds, and consequently have shorter half-lives in soil and water. Methylene chloride, the primary organic contaminant detected in groundwater, has a solubility of 20,000 mg/l, which makes it a highly mobile compound in contrast to 2-methylnaphthalene, another groundwater contaminant, which has a solubility of 26 mg/l. The second most commonly detected groundwater contaminant at the site, cholorform, has a solubility of 8,200 mg/l.

In contrast to VOCs, SVOCs have higher octanol-water partition coefficients (K_{ow}), resulting in greater partitioning to soil organic carbon and soil particulates (especially silt- and clay-sized grains). SVOCs, such as PAHs and pesticides, bond strongly to soil, making them vulnerable to transport as fugitive dust or eroded surface soils. For example, 2-methylnaphthalene, with a K_{ow} value of 7,244, tends to bond strongly to soil and is not at all mobile in groundwater. Conversely, methylene chloride, with a K_{ow} of 20, is relatively mobile in groundwater and leaches rapidly through soil.

The variation in aqueous solubilities, vapor pressures, and K_{ow} for VOCs and SVOCs is also directly reflected in the susceptibility of these compounds to chemical and biological degradation. The susceptibility to degradation is represented by the half-life of the compound in soil, surface water, groundwater, and air. The half-life of a compound in an environmental medium is the time it takes for one-half of the compound to leave the medium either by migration or transformation. For example, methylene chloride has a half-life of 2 to 8 weeks in groundwater, which compares to a half-life of 2 days to 12 months for 2,6-dinitrotoluene, depending on site conditions. Chlorinated hydrocarbons and pesticides, which are generally more resistant to aerobic degradation processes than nonchlorinated compounds such as benzene, are more persistent in soil and have longer half-lives. Nonchlorinated hydrocarbons such as the BTEX compounds are generally susceptible to aerobic degradation and typically have shorter half-lives in soil than chlorinated compounds. The opposite situation may be true, however, for anaerobic settings such as deep or confined aquifers or anoxic sediment and soil.

In general, the chemical properties of VOCs relative to SVOCs, pesticides, and explosives make them more susceptible to migration by volatilization processes and advective flow in surface water and groundwater. Conversely, SVOCs are more susceptible to migration in the solid phase, i.e., adsorbed to dust or soil, and have much less potential for transport in the dissolved phase. SVOCs also tend to be more persistent in soil-water environments relative to VOCs.

4.1.3.3 Contaminant Fate and Migration

Contaminant transport processes considered to be important at SWMUs 1 and 25 include mobilization of near-surface contaminants by wind and surface-water runoff and transport of surficial contamination to subsurface soil and shallow groundwater by leaching processes. However, given site conditions, including source characteristics, the semiarid climate, fine-grained vadose zone and aquifer materials, and contaminant types and distribution, contaminant migration is expected to be minimal. Soil in direct contact with contaminant sources (mortar piles, windrows, ash mounds, trenches, and explosion craters) has the highest potential for contamination.

Air

The potential for eolian erosion and subsequent off-post transport of contaminants exists at SWMUs 1 and 25 due to the typically dry surface soil and low density of vegetation. Recent closure of the explosion craters at SWMU 25 has decreased the potential for eolian transport from that area. Other source areas, including the ash mounds and windrows, remain exposed to the erosive winds. The annual windrose for TEAD-S indicates a diurnal flow pattern that varies from northwesterly flow to southeasterly flow. While occasional wind and dust storms occur in the region, long-term ambient air monitoring data collected at TEAD-S indicate that particulate matter less than 10 microns (PM-10) concentrations are low, averaging 10 $\mu g/m^3$ across TEAD-S according to data furnished by the Tooele Army Depot meteorological team.

Soils

Surface soil contaminant transport can occur through wind erosion, fugitive dust emissions, or episodic erosion during periods of rapid rainfall, flash floods, or snowmelt. Subsurface soil contaminants are susceptible to downward migration by leaching through the unsaturated zone. Infiltration is enhanced where surface and meteoric water may collect in trenches, craters, or other depressions. Infiltration can transport surface soil and surface water contaminants to subsurface soil and groundwater. While the clayey nature of soil at the SWMUs inhibits downward migration of the bulk of contaminants, transport via macropores and shrinkage cracks may occur, as evidenced by minor detections of groundwater contaminants.

Surface Water

In this sparsely vegetated area, significant soil erosion by overland flow can be expected during periods of rapid snowmelt, rain storms, and flash flood events at SWMUs 1 and 25. Snowmelt in spring 1993 was observed to have flowed south from SWMU 1 across the SWMU boundary

to adjacent ranchland, where infiltration and evaporation soon followed. These seasonal events can form erosional channels and pools of standing water. These transport mechanisms may redistribute contaminants across and downslope from the SWMUs.

Groundwater

Detections of organic contaminants in wells at SWMUs 1 and 25 indicate that contaminants have migrated from surface source areas to groundwater. However, the number of detections and concentrations of contaminants are low, given the use history and length of operation of these SWMUs, as detections are generally sporadic and of low part-per-billion concentrations. Methylene chloride was the most commonly detected analyte during the RFI-Phase II sampling, and was generally detected at low levels. At one well (S-97-92) however, its concentration ranged as high as 500 µg/l (Table 4.1-12, Figure 4.1-40).

The depth to groundwater is 33 to 100 ft at SWMU 1 and 15 to 69 ft at SWMU 25. Groundwater flow rates calculated from site hydrologic data indicate that groundwater flows relatively slowly, moving at a rate of approximately 3 to 15 ft per year. Coupled with the desert climate at TEAD-S—high evapotranspiration and minimal groundwater recharge through the unsaturated zone—the potential to move large amounts of contaminants to the water table and through the aquifer is considered low.

Downward hydraulic gradients at SWMU 1 indicate that contaminants in shallow groundwater may reach deeper hydrostratigraphic units. Potential upward hydraulic gradients at SWMU 25 decrease the potential for migration to deeper water-bearing units. Furthermore, field observations have also indicated that perched groundwater zones may exist. Perched zones are characterized by hydraulic discontinuity between other hydrostratigraphic units, occupying beds of higher porosity and permeability that pinch out in less permeable, fine-grained deposits. Perched conditions can significantly limit the ability of groundwater to migrate laterally, thereby restricting the transport of contaminants. Moreover, at SWMUs 1 and 25, the fine-grained soil and high soil pH increase the probability that contaminant migration is attenuated by adsorption or precipitation on inorganic mineral surfaces and organic carbon.

4.2 RFI-PHASE II RESULTS FOR SWMU 37

4.2.1 Background

4.2.1.1 Site Description and Waste Generation

USAEC and the State of Utah Division of Solid and Hazardous Waste personnel identified SWMU 37 in 1991. This SWMU is located in a large gravel pit near the center of TEAD-S at Blume Street and Montgomery Road (Figure 4.2-1). Two small hills supporting power line poles remain in the eastern part of the excavation. The SWMU includes two slag or ash piles (the larger one being approximately 30 ft long), two 30-ft-long piles of building demolition rubble and gravel, scattered incendiary and other bomb fragments, and an area of backfilled soil. The slag or ash piles, which are found in the center of the pit approximately 40 ft west of the northern power line support, consist of black slag and ash mixed with fire bricks and composite roofing shingles. Incendiary bomblets are scattered on and near the road that leads down the north side of the gravel pit. However, there is no evidence of a large, systematic incendiary bomb disposal operation such as was found in SWMUs 1 and 25. Rusted bomb fragments a few square inches in size are also scattered over an area of a few hundred square feet on the north side of the pit. Loose, silty, gravelly sand backfill occurs in the west side of the pit. Slag was found mixed with this backfilled soil. The origin of all of these SWMU 37 features is unknown.

4.2.1.2 Hydrogeology

The area surrounding SWMU 37 is a very gentle southwest-sloping topographic surface approximately 5,225 ft above mean sea level. Quaternary alluvial gravel in this area has been excavated to form the pit where this SWMU is located. The pit is 20 to 30 ft deep. Samples collected during the RFI-Phase II program consisted of yellowish-brown, gravelly sand to silty gravel. Several samples appeared to be backfill from elsewhere in the pit or another location.

The underlying unsaturated zone is approximately 80 ft thick below the bottom of the pit and is composed of brownish-gray, sandy gravel. The saturated zone in the closest monitoring well (S-36-90) from approximately 115 to 230 ft is composed of pale brown, silty and sandy gravel. Based on water-level measurements made in July 1990, groundwater at SWMU 37 was estimated to be 115 ft below the natural ground surface at an elevation of 5,110 ft mean sea level. Groundwater may flow to the west because of a groundwater high that appears to underlie a water main paralleling Montgomery Road (Figure 2.1-4)

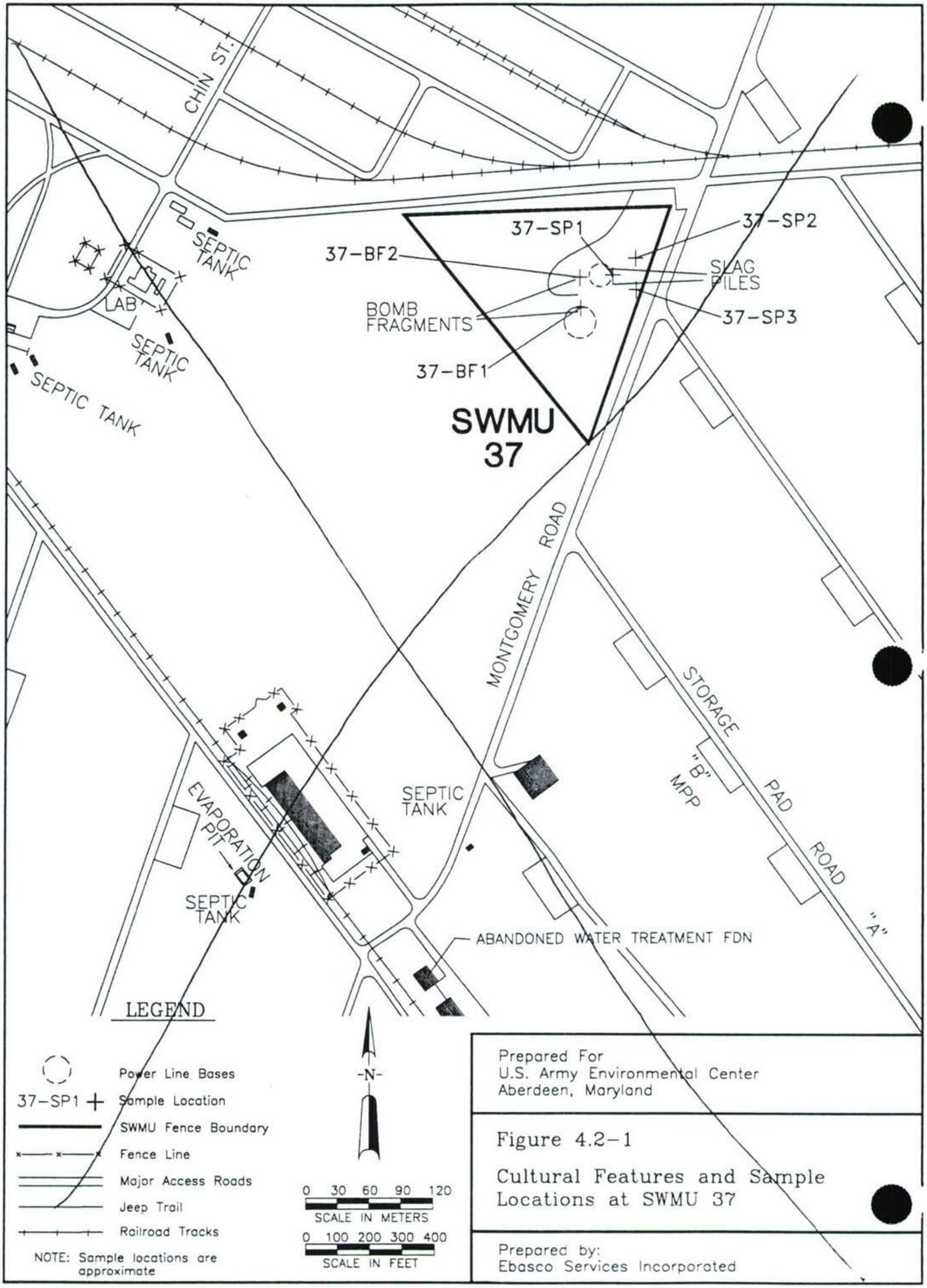
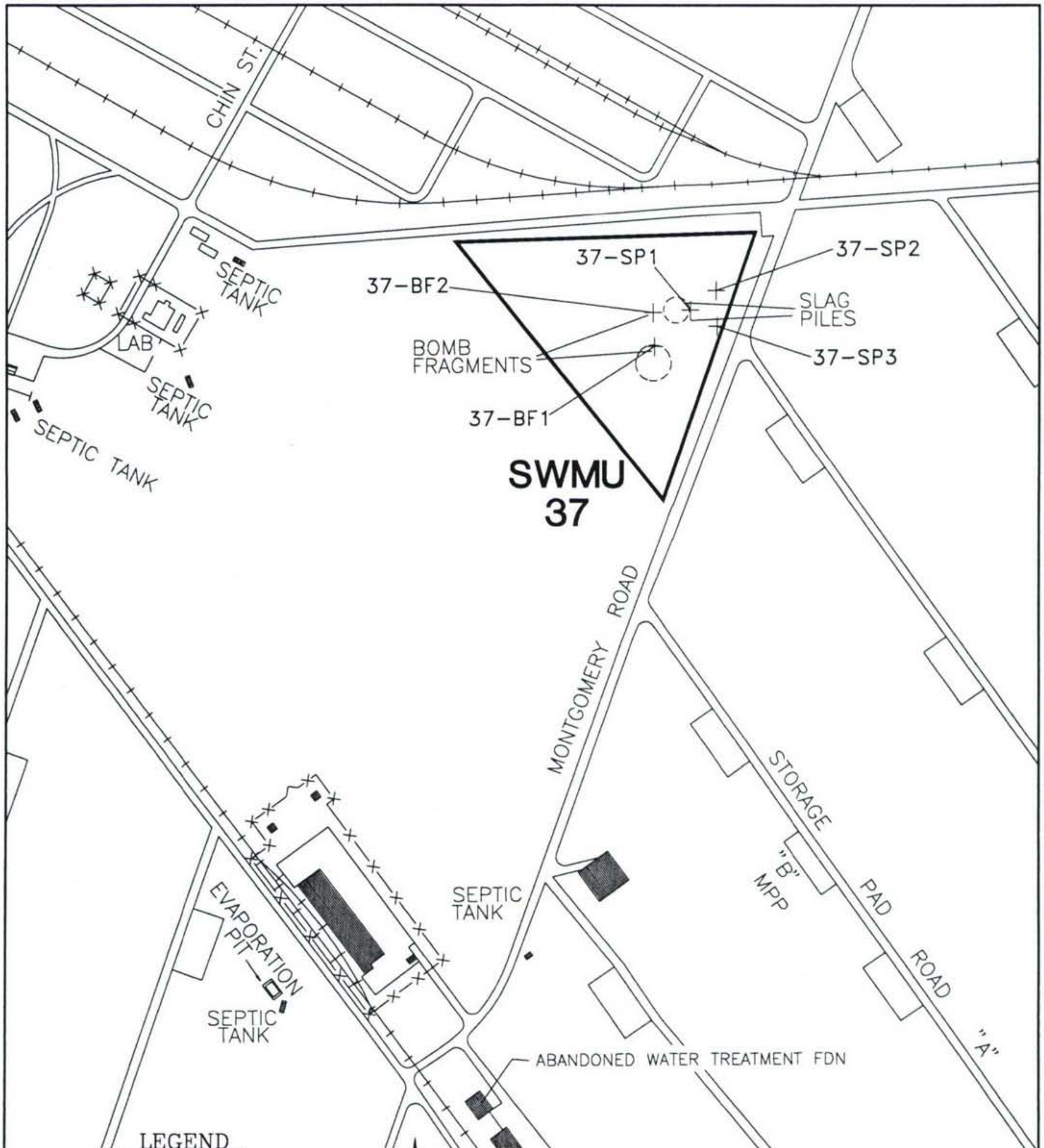


Figure 4.2-1

Cultural Features and Sample Locations at SWMU 37



LEGEND

- Power Line Bases
- 37-SP1 + Sample Location
- SWMU Fence Boundary
- Fence Line
- Major Access Roads
- Railroad Tracks

NOTE: Sample locations are approximate

-N-

0 30 60 90 120
SCALE IN METERS

0 100 200 300 400
SCALE IN FEET

Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 4.2-1

Cultural Features and Sample Locations at SWMU 37

Prepared by:
Ebasco Services Incorporated

4.2.2 Nature and Extent of Contamination

4.2.2.1 Soil Contamination Assessment

SWMU 37 was not sampled prior to this investigation because it was identified after the RFI-Phase I field program of other suspected releases units had been completed. During the RFI-Phase II of SWMUs 1 and 25, samples were collected from five locations to provide Phase I data for SWMU 37 (Figure 4.2-1). The intent of this sampling program was to determine the presence or absence of contamination at this SWMU. At each location, samples were collected from depth intervals of 0 to 2 inches, 6 to 12 inches, and 24 to 36 inches. Four sampling sites were located within slag pile (37-SP1, 2, and 3). Two sites were located west of the slag piles in materials that appeared to be backfill (37-BF1 and 2). Some slag material was present in the 24- to 36-inch sample in 37-BF2. The samples were analyzed for VOCs, SVOCs, explosives, and metals. The detections in these samples (or detections above background) are listed in Table 4.2-1. The complete chemical data for these samples can be found in Appendix F1. Only barium, zinc and benzene were detected in this sample, at levels below regulatory criteria for identification of hazardous waste. Although the laoratory inadvertently omitted mercury analysis of this sample, the slag is unlikely to contain mercury since this metal was not detected above bakground in any SWMU 37 samples.

DNBP is the only target organic analyte detected at SWMU 37 (Figure 4.2-2). Metals detected above background include aluminum, barium, calcium, cadmium, cobalt, chromium, copper, iron, magnesium, manganese, nickel, lead, tin, tellurium, vanadium, and zinc. Most of these metals were detected above background in sample 37-BF2, which is located west of the center of the site. This sample contained slag or ash and backfill materials. The remaining samples contained fewer or no metals above background (Figure 4.2-3). Because several metals were detected in samples from the 2- to 3-ft interval at concentrations two or more times background, the vertical extent of contamination has not been defined. To evaluate the detected concentrations, the detected levels of metals above background were compared to action levels listed in Appendix A of a proposed rule on Corrective Action for SWMUs (40 CFR 264, Subpart S). None of the action levels were exceeded. Some of the detected metals are not listed in the proposed rule or are listed as components of compounds rather than as total metals. However, since the RFI-Phase II total metals results are below the action levels for the metallic compounds, the action levels would not be triggered. This conclusion is appropriate since all of the metals detected above background at this SWMU occur commonly in the environment and have low to negligible toxicity. In addition, these action levels are considered to be conservative for TEAD-S since they

Table 4.2-1 Chemical Analytical Detections in Soil Samples from SWMU 37

Analyte	Location	Depth (feet)	Value	Unit
SWMU 37 - Bomb Fragments				
AL	37-BF2	0.100	19000.000	UGG
B	37-BF1	0.100	16.100	UGG
B	37-BF1	0.900	9.430	UGG
B	37-BF1	2.500	14.100	UGG
B	37-BF2	0.100	23.100	UGG
B	37-BF2	0.900	15.800	UGG
BA	37-BF1	0.900	1500.000	UGG
BA	37-BF1	2.500	645.000	UGG
BA	37-BF2	0.900	480.000	UGG
BA	37-BF2	2.500	885.000	UGG
CD	37-BF2	0.100	2.570	UGG
CD	37-BF2	0.900	1.980	UGG
CD	37-BF2	2.500	2.460	UGG
CO	37-BF2	0.100	6.730	UGG
CR	37-BF2	0.100	25.500	UGG
CU	37-BF1	0.100	71.900	UGG
CU	37-BF1	0.900	198.000	UGG
CU	37-BF1	2.500	166.000	UGG
CU	37-BF2	0.100	108.000	UGG
CU	37-BF2	0.900	257.000	UGG
CU	37-BF2	2.500	407.000	UGG
FE	37-BF1	0.900	27500.000	UGG
FE	37-BF2	0.100	30500.000	UGG
FE	37-BF2	0.900	150000.000	UGG
FE	37-BF2	2.500	110000.000	UGG
MG	37-BF1	0.900	19700.000	UGG
MG	37-BF1	2.500	25000.000	UGG
MG	37-BF2	0.100	21600.000	UGG
MG	37-BF2	0.900	18200.000	UGG
MG	37-BF2	2.500	16700.000	UGG
MN	37-BF2	0.900	650.000	UGG
MN	37-BF2	2.500	835.000	UGG
NI	37-BF2	0.100	19.800	UGG
NI	37-BF2	0.900	39.200	UGG
NI	37-BF2	2.500	38.400	UGG
PB	37-BF1	0.100	52.000	UGG
PB	37-BF1	2.500	37.000	UGG
PB	37-BF2	0.100	46.000	UGG
PB	37-BF2	0.900	150.000	UGG
PB	37-BF2	2.500	130.000	UGG
SN	37-BF1	0.900	9.910	UGG
SN	37-BF2	0.900	21.400	UGG
SN	37-BF2	2.500	17.700	UGG
V	37-BF1	0.100	25.700	UGG
V	37-BF2	0.100	34.900	UGG
ZN	37-BF1	0.100	116.000	UGG
ZN	37-BF2	0.100	142.000	UGG
ZN	37-BF2	0.900	437.000	UGG
ZN	37-BF2	2.500	173.000	UGG

Analyte	Location	Depth (feet)	Value	Unit
SWMU 37 - Slagpiles				
B	37-SP1	0.100	33.100	UGG
B	37-SP1	0.900	9.640	UGG
B	37-SP1	2.500	8.910	UGG
B	37-SP2	0.100	13.100	UGG
B	37-SP3	0.100	12.300	UGG
B	37-SP3	0.900	12.700	UGG
CA	37-SP1	0.100	150000.000	UGG
CA	37-SP2	0.100	170000.000	UGG
CA	37-SP3	0.100	200000.000	UGG
CA	37-SP3	2.500	380000.000	UGG
DNBP	37-SP1	0.900	2.300	UGG
DNBP	37-SP2	0.100	3.800	UGG
MG	37-SP2	2.500	53100.000	UGG
TE	37-SP2	0.900	55.100	UGG

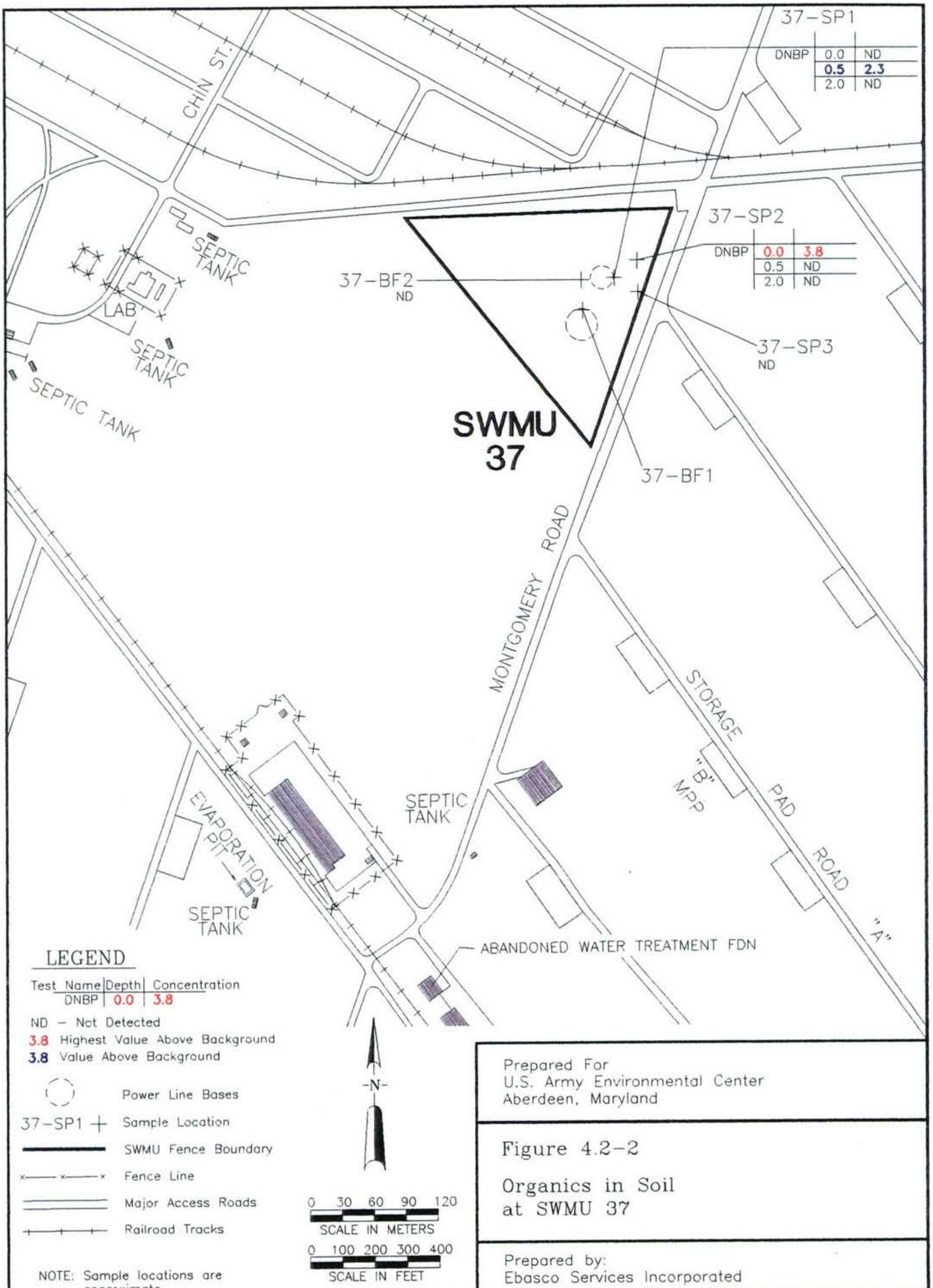


Figure 4.2-2

Organics in Soil at SWMU 37

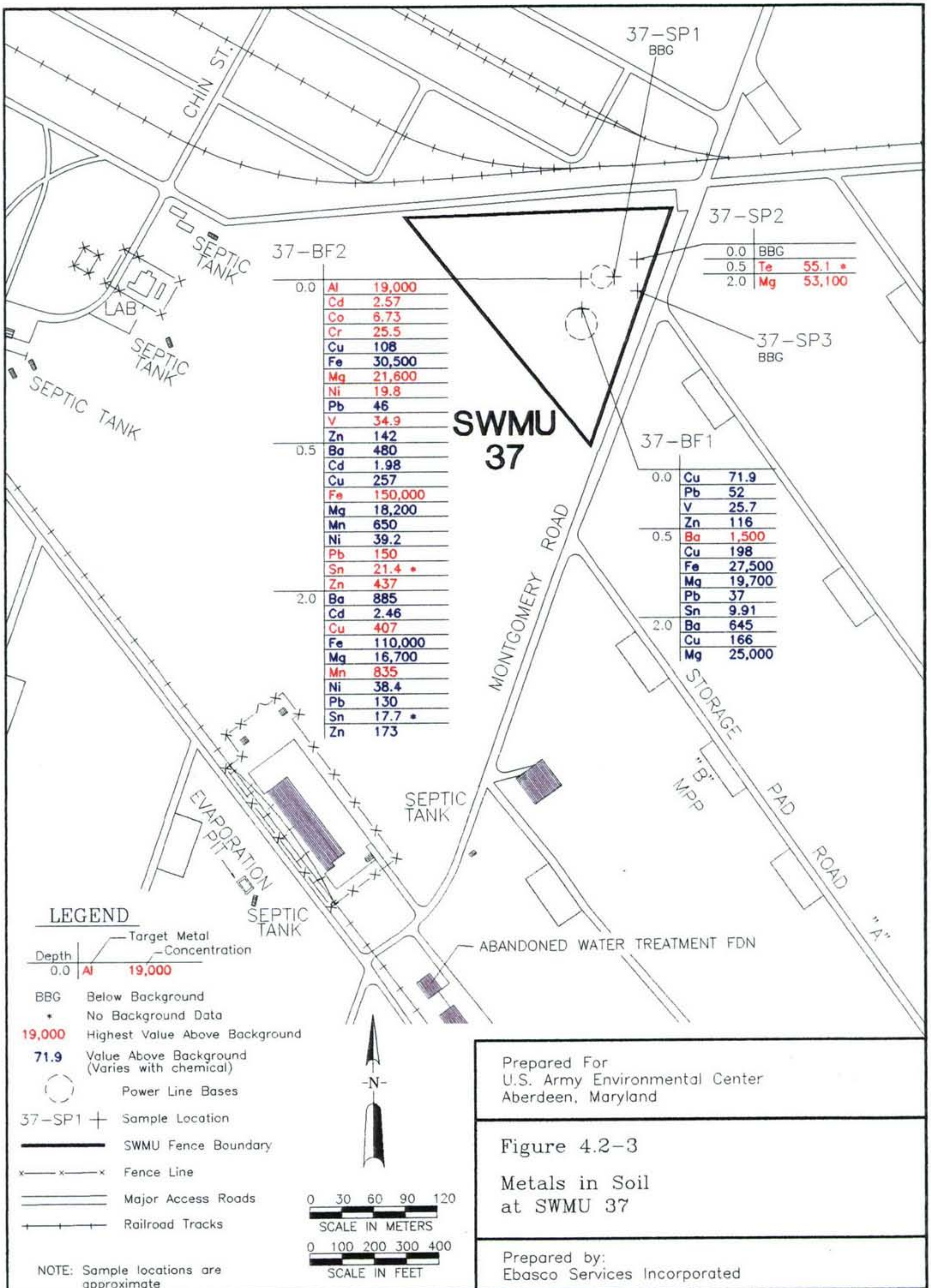


Figure 4.2-3

Metals in Soil at SWMU 37

were developed on the basis of residential exposures, which are greater than would occur under conditions of continued industrial use of TEAD-S by the Army.

4.2.2.2 Solid Waste Assessment

A single sample of slag was collected from the slag piles and analyzed for RCRA characteristics of toxicity, ignitability, corrosivity, and reactivity.

4.2.3 Recommendations

Since elevated metal concentrations in backfilled material is unknown, further sampling is recommended at SWMU 37. In addition, the slag and ash piles, incendiary bomblets, and any other ordnance should be removed and disposed of properly.

5.0 BASELINE RISK ASSESSMENT FOR SWMUs 1 AND 25

5.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section evaluates human health risks associated with potential exposures to chemicals in soil and groundwater at TEAD-S SWMUs 1 and 25 using the RFI-Phase II analytical results discussed in Section 4.0, combined with pertinent environmental setting and land-use information. Soil exposure pathways are evaluated separately for each SWMU and, given the limited scope of the subsurface investigation discussed in Section 1.1, these analyses are based on surface soil (0.1 ft) data only. Both current use and hypothetical future use (residential/agricultural) pathways are quantitatively evaluated. Because future residential use of TEAD-S is not anticipated, the residential scenario is presented for comparison purposes only (e.g., to other SWMU-specific evaluations), and will not be used as the basis for any subsequent risk management decisions.

All methods used in this evaluation are in general accordance with guidelines presented in the State of Utah Hazardous Waste Management Rules (USHWCB 1994), the proposed EPA Guidance for RCRA RFIs (EPA 1989c), and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989d). Consistent with these guidelines, the baseline human health risk assessment was developed according to the following steps:

- Identification of chemicals of concern (COCs; Section 5.1.1)
- Human health exposure assessment (Section 5.1.2)
- Toxicity assessment (Section 5.1.3)
- Risk characterization (Section 5.1.4)

These steps are described in the following sections.

5.1.1 Identification of Chemicals of Concern

COCs are those chemicals that are to be evaluated in the risk assessment process. COCs were selected for both surface soil (Section 5.1.1.1) and groundwater (Section 5.1.1.2) based on the analytical results presented in Section 4.0.

5.1.1.1 Surface Soil Chemicals of Concern

Surface soil COCs were selected on the basis of the three following primary factors:

> Frequency of detection—chemicals detected at frequencies less than five percent were excluded from further evaluation

- Toxicity—chemicals that are essential human nutrients and toxic only at very high doses were excluded from further consideration (e.g., calcium, iron, magnesium, potassium, and sodium).

- Comparison to background levels—Inorganic constituents with maximum concentrations below the site-specific background levels determined in Section 2.3 were not selected as COCs.

Tables 5.1-1 and 5.1-2 detail the COC selection process for SWMU 1 and SWMU 25 soils, respectively. Based on the rationale presented in these tables, the following surface soil COCs were selected for evaluation:

- Aluminum
- Antimony (SWMU 25 only)
- Arsenic (SWMU 1 only)
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Cyanide
- Lead
- Manganese
- Mercury
- Nickel
- Silver
- Thallium
- Vanadium
- Zinc

5.1.1.2 Groundwater Chemicals of Concern

Groundwater COCs were selected on the basis of the following factors:

- Frequency of detection—Chemicals detected in groundwater at frequencies less than 5 percent were excluded from further evaluation

- Comparison of inorganic chemical concentrations with upgradient (background) groundwater levels—Constituents detected at concentrations less than the site-specific background level were not selected as COCs

- Toxicity—Chemicals with negligible toxicity to humans (e.g., calcium and other common nutrients) were excluded from further consideration

Using these criteria, which were applied as summarized in Table 5.1-3, the following constituents were selected as groundwater COCs:

- Antimony
- Carbon tetrachloride

Table 5.1-1 Identification of COCs for SWMU 1 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/45)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data?	Selected as COC?	Rationale for Selection or Exclusion as COC
INORGANIC CONSTITUENTS									
Aluminum	**45**	**100%**	**10,100**	**170,000.00**	**01-PBA-55 (CBA)**	**17,700.00**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 69% of samples (31/45); potential toxicity. However, given that Al is a ubiquitous component of aluminosilicate minerals, selection as a COC is very conservative.**
Antimony	1	2%	26.30	26.30	01-PBA-55 (CBA)	Not Detected (outlier= 3.57)	Yes	No	Not selected as a COC for SWMU 1 due to low frequency of occurrence (<5%). However, the single (26.3 µg/g) result for the 01-PBA-55 sample may be quantitatively addressed as maxima for several other COCs were also detected at this location.
Arsenic	**45**	**100%**	**4.26**	**77**	**01-IAM-13 (IBA)**	**27.30**	**Yes**	**Yes**	**100% frequency of detection and potential toxicity. However, exceeds background in only 7% of samples (3/45); selection as COC is therefore conservative. Arsenic is naturally elevated in desert soil, particularly in playa and salt-flat environments.**
Barium	**45**	**100%**	**126**	**21,000**	**01-PBA-55 (CBA)**	**536**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 24% of samples (11/45); potential toxicity.**
Beryllium	**29**	**64%**	**0.55**	**1.15**	**01-TA-301 (CAOT)**	**0.89**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity. However, exceeds background in only 9% of samples (4/45); selection as COC is therefore conservative. The ore-grade beryllium deposits in surrounding mountains may be a potential source of the Be detected on-site.**

Notes: All units in µg/g (ppm).
Shaded chemicals were selected as soil COCs for SWMU 1.

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Parameter	No. Detects	Detection Frequency (/45)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data?	Selected as COC?	Rationale for Selection or Exclusion as COC
Cadmium	**19**	**42%**	**1.56**	**141**	**01-PBA-55 (CBA)**	**0.98**	**Yes**	**Yes**	**Frequency of detection >5%; exceeds background in 42% of samples (19/45); potential toxicity.**
Calcium	45	100%	7,620	240,000	01-DA-441 (CAOT)	146,000	No	No	Exceeds background in 36 percent of samples (16/45). However, not selected as COC given that Ca is a naturally occurring essential human nutrient with negligible toxicity.
Chromium	**45**	**100%**	**10.10**	**5,300**	**01-PBA-55 (CBA)**	**25.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 42% of samples (19/45); potential toxicity. The elevated concentrations detected in TEAD-S soils may represent particulate chrome from solid munitions casings, etc. Although no speciation was conducted for the chemical analysis, the most likely form is trivalent chromium (vs. hexavalent) given the geochemistry of TEAD-S soils.**
Cobalt	**43**	**96%**	**3.42**	**52**	**01-SPDA-99 (CAOT)**	**6.61**	**No**	**Yes**	**High (96%) frequency of detection; exceeds background in 33% of samples (15/45). Toxicity criteria are not available, however, precluding quantitative evaluation. Therefore, a qualitative evaluation of potenial toxicity is provided in Appendix L.**
Copper	**45**	**100%**	**14.20**	**6,700**	**01-PBA-55 (CBA)**	**25.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 62% of samples (28/45); potential toxicity. The elevated levels may represent particulate copper from solid-waste sources (wiring, etc.).**

Notes: All units in µg/g (ppm).
Shaded chemicals were selected as soil COCs for SWMU 1.

Table 5.1-1 Identification of COCs for SWMU 1 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/45)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data?	Selected as COC?	Rationale for Selection or Exclusion as COC
Cyanide	**11**	**24%**	**0.32**	**5.98**	**01-MSD-58 (CAOT)**	**--**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity (background data not available).**
Iron	45	100%	7,850	320,000	01-SPDA-99 (CAOT)	17,500	No	No	Exceeds background in 51% of samples (23/45). However, not selected as COC given that Fe is a naturally occurring essential human nutrient and no toxicity criteria are available.
Lead	**45**	**100%**	**6.97**	**1,100**	**01-SPDA-99 (CAOT)**	**34.8**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 36% of samples (16/45); potential toxicity. Potential sources of lead at TEAD-S may be leaded fuel used for burning, particulate lead from solid-waste, or natural lead hydroxy carbonate minerals.**
Magnesium	45	100%	10,700	100,000	01-IAM-8 (IBA)	16,200	No	No	Exceeds background in 82% of samples (37/45). However, not selected as COC given that Mg is a naturally occurring essential human nutrient with negligible toxicity.
Manganese	**45**	**100%**	**233**	**2,300**	**01-PBA-55 (CBA)**	**658**	**Yes**	**Yes**	**100% frequency of detection and potential toxicity. However, exceeds background in only 13% of samples (6/45); selection as COC is therefore conservative. Also, manganese is a ubiquitous mineral in desert soils.**
Mercury	**6**	**13%**	**0.06**	**0.17**	**01-IAM-13 (IBA)**	**0.08**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity. However, because Hg exceeds background in only 9% of samples (4/45), selection as COC may be conservative.**
Nickel	**45**	**100%**	**4.59**	**456**	**01-PBA-55 (CBA)**	**19.50**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 24% of samples (11/45); potential toxicity.**

Notes: All units in µg/g (ppm).
Shaded chemicals were selected as soil COCs for SWMU 1.

Table 5.1-1 Identification of COCs for SWMU 1 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/45)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data?	Selected as COC?	Rationale for Selection or Exclusion as COC
Potassium	45	100%	407	20,300	01-IA-88 (CAOT)	7,940	No	No	Exceeds background in 31% of samples (14/45). However, not selected as COC given that K is a naturally occurring essential human nutrient with negligible toxicity.
Silver	**4**	**16% (N=25)**	**1.19**	**5.13**	**01-CBA-8 (CBA)**	**0.44**	**Yes**	**Yes**	**Frequency of detection >5% (localized occurrence); exceeds background in all 4 samples detected; potential toxicity.**
Sodium	44	98%	298	11,500	01-IA-88 (CAOT)	1,540	No	No	Exceeds background in only 4 samples; not selected as COC given that Na is naturally occurring and has negligible toxicity.
Thallium	**3**	**7%**	**43.30**	**73**	**01-PCA-88 (CAOT)**	**49.90**	**Yes**	**Yes**	**Frequency of detection exceeds 5%; potential toxicity. However, only two detections exceed background, but one (54.3 µg/g) only slightly. Given this limited occurrence, selection of Tl as a soil COC is considered conservative.**
Vanadium	**44**	**98%**	**9.61**	**33.50**	**01-TA-301 (CAOT)**	**23.10**	**Yes**	**Yes**	**High (97%) frequency of detection; exceeds background in 40% of samples (18/45); potential toxicity. Highest concentrations are likely elevated naturally occurring vanadium, or from fuel used for burning.**
Zinc	**45**	**100%**	**47.80**	**24,000**	**01-SPDA-99 (CAOT)**	**104**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 56% of samples (25/45); potential toxicity.**

Notes: All units in µg/g (ppm).
Shaded chemicals were selected as soil COCs for SWMU 1.

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Table 5.1-1 Identification of COCs for SWMU 1 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/45)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data?	Selected as COC?	Rationale for Selection or Exclusion as COC
ORGANIC CONSTITUENTS									
Acenaphthene	1	2%	0.076	0.076	01-SPDA-77 (CAOT)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency < 5%.
Bis(2-ethylhexyl) phthalate	1	2%	8.40	8.40	01-SPDA-99 (CAOT)	--	Yes	No	Single isolated occurrence; detection frequency < 5%.
Dithiane	1	2%	0.28	0.28	01-TA-302 (CAOT)	--	No	No	Single isolated occurrence; detection frequency < 5%.
Fluoroacetic Acid	1	2%	2.47	2.47	01-MP-89B (CAOT)	--	Yes	No	Single isolated occurrence; detection frequency < 5%.
Hexachlorobenzene	1	2%	0.94	0.94	01-SPDA-99 (CAOT)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency < 5%.
Phenanthrene	1	2%	0.24	0.24	01-SPDA-77 (CAOT)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency < 5%.
Pyrene	1	2%	0.18	0.18	01-MP-82 (CAOT)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency < 5%.
2-Methyl naphthalene	1	2%	0.23	0.23	01-SPDA-77 (CAOT)	--	No	No	Single isolated occurrence at low concentration; detection frequency < 5%.

Notes: All units in µg/g (ppm).
Shaded chemicals were selected as soil COCs for SWMU 1.

Table 5.1-2 Identification of COCs for SWMU 25 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/21)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data	Selected as COC	Rationale for Selection or Exclusion as COC
INORGANIC CONSTITUENTS									
Aluminum	**21**	**100%**	**14,100**	**43,100**	**25-IBA-67 (IBA)**	**17,700**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 81% of samples (17/21); potential toxicity.**
Antimony	**2**	**10%**	**35.70**	**81**	**25-IBA-67 (IBA)**	**Not Detected (outlier= 3.57)**	**Yes**	**Yes**	**Although presence clearly localized, Sb conservatively selected as COC given that detected concentrations are well above background; frequency >5%; and potential toxicity. Maxima for several other COCs were detected at the 25-IBA-67 location.**
Arsenic	21	100%	4.98	20.20	25-IBA-60 (IBA)	27.30	Yes	No	All detected concentrations are less than the site-specific background value.
Barium	**21**	**100%**	**155.50**	**18,000**	**25-IBA-65 (IBA)**	**536**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 43% of samples (9/21); potential toxicity.**
Beryllium	**12**	**57%**	**0.57**	**1.28**	**25-ODC-110 (HEC)**	**0.89**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity. Exceeds background in 19% of samples (4/21), but not by a large amount; selection as a COC may therefore be conservative.**
Cadmium	**10**	**48%**	**1.56**	**4.59**	**25-WIND**	**0.98**	**Yes**	**Yes**	**Frequency of detection > 5%; exceeds background in all 10 samples in which Cd was detected (10/21, or 48%); potential toxicity.**
Calcium	21	100%	16,200	210,000	25-UA1	146,000	No	No	Exceeds background in only 10% of samples (2/21). Not selected as COC given that Ca is a naturally occurring essential human nutrient with negligible toxicity.
Chromium	**21**	**100%**	**12.90**	**1,400**	**25-IBA-65 (IBA)**	**25.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 76% of samples (16/21); potential toxicity.**

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]).
Bolded chemicals were selected as soil COCs for SWMU 25.

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Parameter	No. Detects	Detection Frequency (/21)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data	Selected as COC	Rationale for Selection or Exclusion as COC
Cobalt	**21**	**100%**	**3.03**	**13.40**	**25-IBA-65 (IBA)**	**6.61**	**No**	**Yes**	**100% frequency of detection; exceeds background in 52% of samples (11/21). Toxicity criteria are not available, however, precluding quantitative evaluation. Therefore, a qualitative evaluation of potential toxicity is provided in Appendix L.**
Copper	**21**	**100%**	**10.45**	**2,300**	**25-IBA-67 (IBA)**	**25.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 62% of samples (13/21); potential toxicity.**
Cyanide	**7**	**33%**	**0.39**	**18**	**25-IBA-67 (IBA)**	**--**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity (background data not available).**
Iron	21	100%	10,900	190,000		17,500	No	No	Exceeds background in 71% of samples (15/21). However, not selected as COC given that Fe is a naturally occurring essential human nutrient that is toxic only at very high doses.
Lead	**21**	**100%**	**9.14**	**410**	**25-IBA-67 (IBA)**	**34.80**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 57% of samples (12/21); potential toxicity**
Magnesium	21	100%	15,700	230,000	25-IBA-65 (IBA)	16,200	No	No	Exceeds background in 86% of samples (18/21). However, not selected as COC given that Mg is a naturally occurring essential human nutrient.
Manganese	**21**	**100%**	**343**	**920**	**25-WIND**	**658**	**Yes**	**Yes**	**100% frequency of detection and potential toxicity. Exceeds background in only 24% of samples (5/21); selection as COC may therefore be conservative.**
Mercury	**4**	**19%**	**0.055**	**0.305**	**25-CT-07 (CT)**	**0.084**	**Yes**	**Yes**	**Frequency of detection >5%; potential toxicity. However, because Hg exceeds background in only one sample, selection as COC is conservative.**

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]).
Bolded chemicals were selected as soil COCs for SWMU 25.

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Table 5.1-2 Identification of COCs for SWMU 25 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/21)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data	Selected as COC	Rationale for Selection or Exclusion as COC
Nickel	**21**	**100%**	**7.55**	**151**	**25-WIND**	**19.50**	**Yes**	**Yes**	**Frequency of detection > 5%; exceeds background in 38% of samples (8/21); potential toxicity.**
Potassium	21	100%	644	14,700	25-ODC-11 (HEC)	7,940	No	No	Exceeds background in 33% samples (7/21). However, not selected as a COC given that K is a naturally occurring essential human nutrient.
Selenium	1	5%	2.65	2.65		Not Detected	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
Silver	**7**	**33%**	**1.33**	**13.20**	**25-IBA-67 (IBA)**	**0.44**	**Yes**	**Yes**	**Frequency of detection >5% (localized occurrence); exceeds background in all 7 samples in which Ag was detected; potential toxicity.**
Sodium	20	95%	19.35	2,640	25-ODC-11 (HEC)	1,540	No	No	Exceeds background in only 2 samples; not selected as VCOC given that Na is naturally occurring and has negligible toxicity.
~~**Thallium**~~	~~**3**~~	~~**14%**~~	~~**40.8**~~	~~**52.60**~~	~~**25-IBA-65**~~ **(IBA)**	**49.90**	**Yes**	**Yes**	**Frequency exceeds 5%; ~~potential toxicity;~~ ~~however,~~ only one of the three detections exceeds background, and the exceedance is slight (52.6 μg/g vs. 49.9 μg/g). Selection as a COC is therefore considered conservative.**
Vanadium	**21**	**100%**	**5.95**	**41.10**	**25-CT-08 (CT)**	**23.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 62% of samples (13/21); potential toxicity.**
Zinc	**21**	**100%**	**31.8**	**927**	**25-AM-58 (AM)**	**104**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 38% of samples (8/21); potential toxicity.**

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Notes: All units in micrograms per liter (μg/l) (parts per billion [ppb]).
Bolded chemicals were selected as soil COCs for SWMU 25.

Parameter	No. Detects	Detection Frequency (/21)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data	Selected as COC	Rationale for Selection or Exclusion as COC
Thallium	**3**	**14%**	**40.8**	**52.60**	**25-IBA-65 (IBA)**	**49.90**	**Yes**	**Yes**	**Frequency exceeds 5%; potential toxicity; however, only one of the three detections exceeds background, and the exceedance is slight (52.6 µg/g vs. 49.9 µg/g). Selection as a COC is therefore considered conservative.**
Vanadium	**21**	**100%**	**5.95**	**41.10**	**25-CT-08 (CT)**	**23.10**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 62% of samples (13/21); potential toxicity.**
Zinc	**21**	**100%**	**31.8**	**927**	**25-AM-58 (AM)**	**104**	**Yes**	**Yes**	**100% frequency of detection; exceeds background in 38% of samples (8/21); potential toxicity.**
<u>**ORGANIC CONSTITUENTS**</u>									
Benzo(a)anthracene	1	5%	0.130	0.130	25-IBA-60 (IBA)		Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
Bis(2-ethylhexyl) phthalate (B2EHP)	9	43%	2.20	5.40	25-AM-58 (AM)	--	Yes	No	Although detection frequency exceeds 5%, B2EHP was identified as a method blank contaminant and thus was not selected as a COC. It is also ubiquitous in the environment, particularly in industrial areas, given its use as a plasticizer.
Chrysene	1	5%	0.20	0.20	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
p,p-DDD	1	5%	2.2	2.2	25-IBA-60 (IBA)	--	No	No	Single isolated occurrence at low concentration; detection frequency <5%.
p,p-DDE	1	5%	0.78	0.78	25-IBA-60 (IBA)	--	No	No	Single isolated occurrence at low concentration; detection frequency <5%

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]).
Bolded chemicals were selected as soil COCs for SWMU 25.

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Table 5.1-2 Identification of COCs for SWMU 25 Surface (0.1 ft) Soil

Parameter	No. Detects	Detection Frequency (/21)	Minimum	Maximum	Location of Maximum	Site-Specific Background	Tox Data	Selected as COC	Rationale for Selection or Exclusion as COC
Benzo(a)anthracene	1	5%	0.130	0.130	25-IBA-60 (IBA)	Yes	No		Single isolated occurrence at low concentration; detection frequency <5%.
Bis(2-ethylhexyl) phthalate (B2EHP)	9	43%	2.20	5.40	25-AM-58 (AM)	--	Yes	No	Although detection frequency exceeds 5%, B2EHP was identified as a method blank contaminant and thus was not selected as a COC. It is also ubiquitous in the environment, particularly in industrial areas, given its use as a plasticizer.
Chrysene	1	5%	0.20	0.20	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurence at low concentration; detection frequency <5%.
p,p-DDD	1	5%	2.2	2.2	25-IBA-60 (IBA)	--	No	No	Single isolated occurrence at low concentration; detection frequency <5%.
p,p-DDE	1	5%	0.78	0.78	25-IBA-60 (IBA)	--	No	No	Single isolated occurrence at low concentration; detection frequency <5%.
p,p-DDT	1	5%	0.41	0.41	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%
Benoz(k)fluoranthene	1	5%	0.31	0.31	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurence at low concentration; detection frequency <5%.
Di-n-butylphthalate	1	5%	6.20	6.20	25-CT-07	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%,
Fluoranthene	1	5%	0.35	0.35	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
Phenanthrene	1	5%	0.44	0.44	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
Pyrene	1	5%	0.48	0.48	25-IBA-60 (IBA)	--	Yes	No	Single isolated occurrence at low concentration; detection frequency <5%.
Tetryl	1	5%	77.90	77.90	25-AM-58 (AM)	--	No	No	Not selected as COC due to low frequency of detection.

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]).
Bolded chemicals were selected as soil COCs for SWMU 25.

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Table 5.1-3 Identification of Potential COCs for TEAD-S Groundwater Samples

Parameter	No. Detects	Detection Frequency (/23)	Minimum	Maximum	Upgradient/ Background	MCL/ Criteria	Selected as Potential COC?	Rationale for Selection or Exclusion as Potential Groundwater COC
INORGANIC CONSTITUENTS								
Antimony	**18**	**78%**	**46.9**	**177**	**65.8**	**6.0**	**Yes**	**15 of the 18 detections exceed background; all concentrations exceed the 6.0 μg/l MCL.**
Arsenic	**22**	**96%**	**10.8**	**480**	**420**	**50**	**Yes**	**Only one concentration (480 μg/l) exceeds background; 17 detections exceed the 50 μg/l MCL. Selection as a groundwater COC is considered conservative, as MCL exceedences are likely attributable to upgradient water quality and native soil geochemistry.**
Barium	**23**	**100%**	**5.91**	**73.5**	**ND(25.0)**	**2,000**	**Yes**	**All 23 detections exceed background (not detected). However, the maximum concentration is well below the 2,000 μg/l state and federal MCL, thus selection as a COC is conservative.**
Chromium	1	4%	11.7	11.7	9.26	100	No	Low (< 5%) frequency of detection; the single detection is also less than the MCL. The low prevalence suggests that Cr occurs as Cr^{+3} because Cr^{+6} is much more soluble.
Copper	4	17%	9.62	12.0	20.4	1,000	No	All four detections are below both background and the 1,000 μg/l MCL.
Lead	6	26%	1.52	2.93	24.0	15	No	All six detections are less than background, and well below the 50 μg/l MCL.

Notes: All units in micrograms per liter (μg/l) (parts per billion [ppb]).
MCL - maximum contaminant level
Bolded chemicals were selected as groundwater COCs.
ND = Not Determined
NA = Not Available

Table 5.1-3 Identification of Potential COCs for TEAD-S Groundwater Samples

Parameter	No. Detects	Detection Frequency (/23)	Minimum	Maximum	Upgradient/ Background	MCL/ Criteria	Selected as Potential COC?	Rationale for Selection or Exclusion as Potential Groundwater COC
Selenium	**14**	**61%**	**3.51**	**190**	**13.1**	**50**	**Yes**	**12 samples exceed background; however, only 2 detections exceed the 50 µg/l MCL. Selection as a potential groundwater COC is therefore conservative. Groundwater Se concentrations are typically high in the western U.S. given high TDS levels and the fact that it concentrates in clays and playa soils.**
Thallium	**10**	**44%**	**95.1**	**132**	**ND (6.99)**	**200**	**Yes**	**The 10 detections exceed background, but all are below the 200 µg/l MCL. Selection as a COC is therefore conservative.**
Vanadium	**16**	**70%**	**14.7**	**55.4**	**NA**	**ND**	**Yes**	**No groundwater standards or background data are available for comparison. Given the availability of toxicity criteria, vanadium was conservatively evaluated as a potential groundwater COC.**
Zinc	3	13%	28.5	623	1,400	5,000	No	All 3 detections are less than background and well below the 5,000 µg/l MCL.
<u>ORGANIC CONSTITUENTS</u>								
1,1,1-Trichloroethane	1	4%	2.4	2.4	ND	200	No	Low (< 5%) frequency of detection; also, the single detection is less than the 200 µg/l MCL.
2,6-Dinitrotoluene	1	2% (N = 46)	0.111	0.395	ND	ND	No	Low (< 5%) frequency of detection.
Benzene	1	4%	5.5	5.5	ND	5.0	No	Low (< 5%) frequency of detection; the single detection only slightly exceeds the 5.0 µg/l MCL.
Bis(2-ethyhexyl)phthalate	1	4%	4.4	4.4	ND	ND	No	Low (< 5%) frequency of detection.

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]).
MCL - maximum contaminant level
Bolded chemicals were selected as groundwater COCs.

ND = Not Determined
NA = Not Available

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Table 5.1-3 Identification of Potential COCs for TEAD-S Groundwater Samples

Parameter	No. Detects	Detection Frequency (/23)	Minimum	Maximum	Upgradient/ Background	MCL/ Criteria	Selected as Potential COC?	Rationale for Selection or Exclusion as Potential Groundwater COC
Carbon tetrachloride	**2**	**8%**	**0.63**	**50.0**	**ND**	**5.0**	**Yes**	**Detection frequency > 5%; potential toxicity; maximum concentration exceeds MCL.**
Chloroform	**4**	**16%**	**0.68**	**1.0**	**ND**	**ND**	**Yes**	**Detection frequency > 5%; potential toxicity.**
Ethylbenzene	**2**	**8%**	**8.0**	**16**	**ND**	**700**	**Yes**	**Detection frequency > 5%; potential toxicity. However, both detections are well below the 700 µg/l MCL; selection as a COC is therefore conservative.**
Methylene chloride	**11**	**44%**	**2.7**	**500**	**ND**	**5.0**	**Yes**	**Frequency of detection > 5%; 8/11 detections exceed the 5.0 µg/l MCL. Background data are not available to determine whether concentrations detected in TEAD-S samples are attributable to upgradient water quality.**
Naphthalene	1	4%	5.9	5.9	ND	ND	No	Low (< 5%) frequency of detection.
Toluene	**2**	**8%**	**3.5**	**22**	**ND**	**1,000**	**Yes**	**Detection frequency > 5%; however, both detections are well below the 1,000 µg/l MCL. Selection as a groundwater COC is therefore conservative.**
Xylenes (total)	1	4%	79	79.0	ND	10,000	No	Low (< 5%) frequency of detection; also, the single detection is well below the 10,000 µg/l MCL.

Notes: All units in micrograms per liter (µg/l) (parts per billion [ppb]). ND = Not Determined
MCL - maximum contaminant level NA = Not Available
Bolded chemicals were selected as groundwater COCs.

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- Arsenic
- Barium
- Selenium
- Thallium
- Vanadium
- Chloroform
- Ethylbenzene
- Methylene chloride
- Toluene

Although groundwater results were compared with drinking water standards (e.g., maximum contaminant limits, or MCLs), the presence of a chemical at a level below an MCL did not (alone) warrant exclusion as a COC, given potential cumulative effects associated with exposure to multiple constituents. Therefore, in general, if a chemical was detected in groundwater at a SWMU at a level exceeding background, and toxicity criteria were available, it was considered a groundwater COC and thus carried through the quantitative groundwater pathway evaluations.

5.1.1.3 Summary

Table 5.1-4 summarizes the COCs selected for TEAD-S surface soil and groundwater samples. The site-specific background levels assumed in the selection process were determined using the methods and assumptions described in Section 2.3.

5.1.2 Human Health Exposure Assessment

5.1.2.1 Identification of Exposure Pathways and Receptors

According to EPA risk assessment guidance (EPA 1989d), an exposure pathway consists of the following elements:

- Source and mechanism of chemical release to the environment
- Environmental transport medium
- Point of human or biota contact with the medium (the exposure point)
- Exposure route at the contact point (e.g., ingestion, dermal contact, inhalation)

Exposure pathways were identified based on the following information: land and groundwater use on and surrounding TEAD-S as described in Section 2.1.8, potential chemical release mechanisms and transport processes shown in Figure 4.1-46, and data regarding the current activity patterns of on-site workers obtained through interviews with facility personnel. Table 5.1-5 summarizes the potential pathways of exposure to COCs at TEAD-S for both current

Table 5.1-4 Summary of Potential COCs in TEAD-S Soil and Groundwater Samples

Parameter	SWMU 1 Surface Soil	SWMU 25 Surface Soil	Groundwater Samples
Inorganics			
Aluminum	X	X	
Antimony		X	X
Arsenic	X		X
Barium	X	X	X
Beryllium	X	X	
Cadmium	X	X	
Chromium	X	X	
Cobalt	X	X	
Copper	X	X	
Cyanide	X	X	
Lead	X	X	
Manganese	X	X	
Mercury	X	X	
Nickel	X	X	
Selenium			X
Silver	X	X	
Thallium	X	X	X
Vanadium	X	X	X
Zinc	X	X	
Organics			
Carbon tetrachloride			X
Chloroform			X
Ethylbenzene			X
Methylene chloride			X
Toluene			X

Note: "X" indicates chemical chosen as potential chemical of concern (COCs). Constituents not listed in this table were either not detected or excluded from further evaluation based on the selection criteria defined in Tables 5.1-1 through 5.1-3. For arsenic in groundwater, exceedances of MCLs were noted, but the majority (21) of the 22 detections were below background. Thus, exceedance of groundwater standards for arsenic is likely attributable to upgradient groundwater quality.

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
CURRENT USE SOIL EXPOSURE PATHWAYS					
Surface (0.1 ft) Soil	Site Security Personnel and/or Maintenance Workers	Within SWMU 1 and SWMU 25	Incidental Ingestion of Soil and Dust, Dermal Contact (Direct Contact Pathways)	Yes	SWMUs 1 and 25 are currently inactive, surrounded by a barbed-wire fence, and are rarely entered by site workers according to Chemical Surety staff (Personal Communication, Jones, 1994). However, because occasional access is possible, potential exposures to COCs in surface soil were quantitatively evaluated in the RA assuming workers enter the SWMUs twice per month for a 1-hour inspection of the grounds (Table 5.1-8). Although the surface of both SWMUs is partially vegetated, this analysis assumes that all soil is exposed.

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
Resuspended Surface Soil Particulates	Site Security Personnel and/or Maintenance Workers	Along Perimeter (Fenceline) of SWMUs 1 and 25	Inhalation of Resuspended Soil Particulates	Yes	Site security personnel regularly drive around the perimeter of SWMUs 1 and 25 for a routine inspection of the grounds. According to TEAD Chemical Surety staff, there are three security shifts per day, so a given worker makes only one circuit per day. Each circuit (i.e., the drive around the site or SWMU perimeter) takes approximately 15 minutes. A conservative scenario involving one 30-minute inspection circuit per shift per day (250 days per year) was therefore evaluated using a worst-case (screening level) estimate of COC concentrations in resuspended surface soils. Despite the differences in the assumed exposure frequency (twice per month for the direct contact pathways and once per day for inhalation exposures), the inhalation exposure scenario was evaluated as concomitant with the direct contact pathway (i.e., direct contact and inhalation risks were summed to derive a SWMU-specific total risk). This analysis assumes that a given security officer is exposed to the model's predicted annual 24-hour maximum concentration for the entire exposure period (i.e., 30-minutes per day, 250 days per year).

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Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
Resuspended Surface Soil Particulates	CAMDS Workers	CAMDS	Inhalation of Resuspended Soil Particulates Transferred to CAMDS via Wind Dispersion	Yes	As discussed above, exposure within or in the immediate vicinity of SWMUs 1 and 25 is expected to be very limited. However, people work at the downwind CAMDS facility (approximately 1/2 mile north of SWMU 25 and 2.5 miles northwest of SWMU 1; see Figure 1.0-2). Therefore, potential exposures to constituents in windblown soil particles were evaluated for the CAMDS location using screening level estimates of COC concentrations in SWMU 1 and 25 surface soils, typical fugitive dust emission rates, and assuming exposure to predicted annual 24-hour maximum COC concentrations 10 hours per day, 200 days per year. [Note: For all inhalation pathways, infrequent events resulting in unusual soil disturbance (e.g, wind/dust storms) were considered, but not quantitatively evaluated, due to their acute nature. The inhalation pathway evaluations were developed for chronic (long-term) exposure periods, and were also assumed to address soil exposures associated with any extreme weather event. Also, although potential inhalation exposures to workers at the Area 2 Chemical Ammunition Safeguard Area (CASA) were considered, this scenario was not quantified because air modeling results provided in Appendix K indicate that CAMDS is the worst-case off-site receptor location for both SWMUs 1 and 25 (given its downwind location).]

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
Surface Soil	Trespassers (e.g., child)	Within SWMU 1 and SWMU 25	Direct Contact and Inhalation Soil Exposure Pathways	No	Both SWMUs are surrounded by barbed-wire fences, and the installation is bounded by a 6-ft high chain-link fence. These areas are also regularly patrolled by site security personnel. The nearest residence is located approximately 1 mile west of the TEAD-S border. However, given the general inaccessibility of the TEAD-S facility and round-the-clock security, trespassing is extremely unlikely.
Resuspended Surface Soil Particulates	Nearby Residents	Nearby Towns	Inhalation of Resuspended Soil Particulates Transferred to these Areas via Wind Dispersion	No	The evaluation of worker inhalation exposures at CAMDS defined above is assumed to represent a worst-case analysis of potential off-site exposures to SWMU 1 and 25 surface soil COCs (as this location was assumed to be downwind of the SWMUs). Inhalation risks associated with potential dispersion of soil COCs to off-site residential areas would therefore be less than those quantified for TEAD workers. Consequently, off-site residential exposure pathways were not evaluated quantitatively.
Subsurface Soil	Site Workers	Onsite-Within SWMUs	Ingestion and Dermal Contact	No	Digging is not expected at either of the SWMUs; furthermore, existing data are not sufficient to allow quantitative evaluation of subsurface soil exposure pathways.

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
FUTURE USE SOIL EXPOSURE PATHWAYS					
Soil	Future Residents (Farm Family Scenario)	Onsite (Within SWMUs 1 and 25)	Ingestion, Dermal Contact, and Inhalation Soil Exposure Pathways Associated with Hypothetical Future Residential Use of TEAD-S	Yes	Future residential use of TEAD-S is not expected. Nonetheless, for purposes of comparison (e.g., with other TEAD-S SWMU-specific evaluations), and in accordance with state and federal risk assessment guidelines, this hypothetical future use pathway was quantitatively evaluated using the exposure assumptions outlined in Appendix M.3. This assessment, which was modeled concomitant with the food chain (agricultural) scenario described below, is considered to represent a worst-case screening level evaluation of risks associated with potential exposures to Group 1 SWMU soil COCs. [The analysis uses surface soil data only, as the subsurface soil data are incomplete. Subsurface soil results would be used to model this scenario, however, if these data were available.]

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
Initial Source—Surface Soil at SWMUs 1 and 25; Ultimate Exposure Medium—Food	Future Residents (Farm Family Scenario)	On-Site	Exposures to Soil COCs through the food Chain—Consumption of Homegrown Produce and Animal (Dairy and Meat) Products	Yes	Under the future-use residential scenario described above, agricultural use of TEAD-S is also possible (e.g., grazing, crop cultivation). Potential human exposures to soil COCs at SWMUs 1 and 25 through the food chain were therefore evaluated. Two food chain pathways were analyzed—consumption of homegrown produce and consumption of animal products. Both of these soil/plant/food-ingestion exposure pathways were modeled using the soil and air exposure point concentrations (EPCs) listed in Table 5.1-8. Additionally, the analysis conservatively assumes that the farm family produces 40 percent of what it consumes from the vegetable produce category, and 75 percent of what it consumes from the beef and dairy product categories (Appendix Tables M.2-3 through M.2-8). Risks associated with the soil/plant/food-chain exposure pathways were added to those calculated for the future-use direct contact pathways described above (soil ingestion, dermal contact, and inhalation) to yield a cumulative risk for the future-use residential/agricultural scenario. [The exposure scenarios are identified separately, however, given the differences in methods used to calculate pathway-specific risks (see Appendices M.2 and M.3).]
Surface and Subsurface Soil (SWMUs 1 and 25)	Future Site Workers	Onsite (SWMUs 1 and 25)	Ingestion/Dermal Contact/Inhalation of Soil Particulates	No	Potential future uses of these areas at TEAD have yet to be defined. At this time, potential future industrial uses of SWMUs 1 and 25 are assumed to be the same as those assumed for the current-use evaluation.

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
GROUNDWATER AND SURFACE WATER EXPOSURE PATHWAYS					
Shallow Groundwater (Current Uses)	Off-Post Residents	Off-Post Downgradient Wells Screened in the Shallow Aquifer	Ingestion	No	Groundwater underlying SWMUs 1 and 25 is not potable as water quality standards are exceeded for sulfate, TDS, chloride, fluoride, and in many cases nitrate/nitrite. [Note: On-post wells are located at the extreme upgradient (northern) edge of TEAD-S. Any constituents present in these wells would not be attributable to SWMUs 1 and 25 at the extreme down-gradient (southern) boundary.]
Shallow Groundwater; Ultimate Exposure Medium-Food (Current and Future Uses)	Off-Post Residents	Off-Post Downgradient Shallow Wells, Nearby Agricultural/ Grazing Areas	Exposures to Groundwater COCs through the Food Chain-Ingestion of Meat and Dairy Products	Yes	The nearest downgradient off-post well is the Stookey well, located approximately 1500 ft south of SWMU 25 well S-95-92. Because this off-post well is permitted for stock watering, a worst-case screening level analysis of human exposures to Group 1 SWMU groundwater COCs through the food chain (groundwater/plant/food-ingestion) was conducted. Given the variability in concentrations quantified for the Group 1 SWMU groundwater COCs, modeled estimates of these COCs at the off-post Stookey well would be highly uncertain. Therefore, the evaluation conservatively assumes both RME and maximum concentrations of groundwater COCs in the adjacent off-post (Stookey) stock watering well and concomitant ranching/grazing, and thus represents a worst-case screening level analysis. It is important to note that no evidence exists that the Stookey well is actually used for stock watering purposes.

Table 5.1-5 Potential Pathways of Exposure to COCs at SWMUs 1 and 25

Exposure Medium	Potential Receptor(s)	Receptor Location(s)	Potential Exposure Route(s)	Pathway Quantitatively Evaluated?	Reason for Selection or Exclusion
Shallow Groundwater (Future Uses)	Local Residents	Wells Screened in the Shallow Aquifer	Ingestion, and Inhalation of Volatile COCs while Showering or Washing	Yes	Future use of shallow groundwater underlying SWMUs 1 and 25 is not expected. However, as discussed above (for hypothetical future residential soil exposure pathways), this pathway was nonetheless quantitatively evaluated in the baseline risk assessment, and represents a worst-case screening level evaluation of risks associated with potential exposures to COCs in Group 1 SWMU shallow groundwater.
Deep Groundwater (Current and Future Uses)	Not Known	Off-Site Downgradient Wells Screened in the Deep Aquifer	Ingestion and Other Uses	No	The deeper aquifer is hundreds of feet below the shallow aquifer characterized in this investigation. Consequently, migration of shallow groundwater constituents to this deeper aquifer is not expected. This is particularly true for SWMU 25, given the apparent upward hydraulic gradient observed in this area (see Section 4).
Surface Water	Site Workers, Trespassers	SWMU 1 and 25 Pits and Trenches	Dermal Contact, Incidental Ingestion of Surface Water	No	Following spring snowmelt or large rainfall events, surface water may pond locally in existing trenches and pits. However, the presence of water in these features is ephemeral as much is lost to infiltration and evaporation. Furthermore, even when surface water is present, exposure to this medium is not expected given the limited access described above. Additionally, exposures to soil COCs at off-site locations resulting from runoff (rain or snowmelt) are expected to be negligible, if occurring at all, and thus were not modeled in the risk assessment.

COC - Chemical of concern

and potential future site uses for installation personnel and hypothetical current and future local residents that are considered to have maximum potential exposure to SWMU 1 and 25 COCs. Rationales for exposure scenarios evaluated qualitatively, as well as those not retained, are also presented.

As described in Table 5.1-5, the following exposure pathways under the current land-use scenario were quantitatively evaluated in the risk assessment:

- Incidental ingestion and dermal contact exposures to surface soil COCs at SWMUs 1 and 25 by site security personnel and maintenance workers

- Inhalation of suspended particulates generated from soil containing COCs in SWMUs 1 and 25 for the following three groups of receptors considered to represent maximally exposed individuals:

  — Site security personnel at the SWMU 1 fenceline (perimeter)
  — Site security personnel at the SWMU 25 fenceline (perimeter)
  — Workers at CAMDS (assumed to be off-site downwind receptors)

- Exposures to groundwater COCs through the food chain (consumption of meat and dairy products) by local residents—this analysis conservatively assumes that constituents in groundwater have migrated to the downgradient Stookey stock watering well, that the well is in use, and that local residents ultimately consume the meat and milk from cattle that have used the well (this pathway also potentially applies to the future-use residential/agricultural scenario)

The following exposure pathways were quantitatively evaluated for the hypothetical future-use residential/agricultural (farm family) scenario:

- Ingestion, dermal contact, and inhalation exposures to surface soil COCs at SWMUs 1 and 25 by future (farm family) residents

- Consumption of contaminated homegrown produce and animal (dairy and meat) products at SWMUs 1 and 25 by future farm family residents (these pathways evaluated concomitant with the direct soil exposure scenario defined above)

- Ingestion and inhalation (volatiles only) exposures to groundwater COCs while washing or showering by future residents

Figure 5.1-1 shows the locations of receptors for the pathways included in the quantitative evaluation.

5.1.2.2 Estimation of Chemical Intakes

To calculate chemical intakes (and corresponding risks), the following factors must be estimated:

- Constituent concentration in the medium (i.e., the exposure point concentration [EPC]) to which an individual is exposed

- Amount of constituent taken up by the body via ingestion, dermal absorption, and/or inhalation

- Frequency and duration of exposures

The factors listed above are incorporated in a term referred to as the chronic daily intake (CDI), which represents an estimated average daily dose received via direct contact (soil ingestion and dermal contact) and/or inhalation pathways. CDIs are expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg/day), and are calculated using the pathway-specific equations summarized in Table 5.1-6 and documented in Appendix M. The EPCs used in these equations were derived using the general methods described below (Section 5.1.2.3). Table 5.1-7 lists the human exposure parameters (e.g., the assumed frequency and duration of exposure, soil ingestion and dermal contact rates) used to calculate exposures and risks for current use soil exposure pathways. Appendix M.1 documents corresponding CDI equations along with the detailed risk assessment results. Appendix M.2 and Appendix M.3 detail the assumptions and equations used to calculate risks for agricultural-related and hypothetical future residential use pathways, respectively.

Pathway-specific CDI values were then combined with toxicity factors (Section 5.1.3) to calculate cancer risks and noncancer hazard indices using the methods discussed in Section 5.1.4.

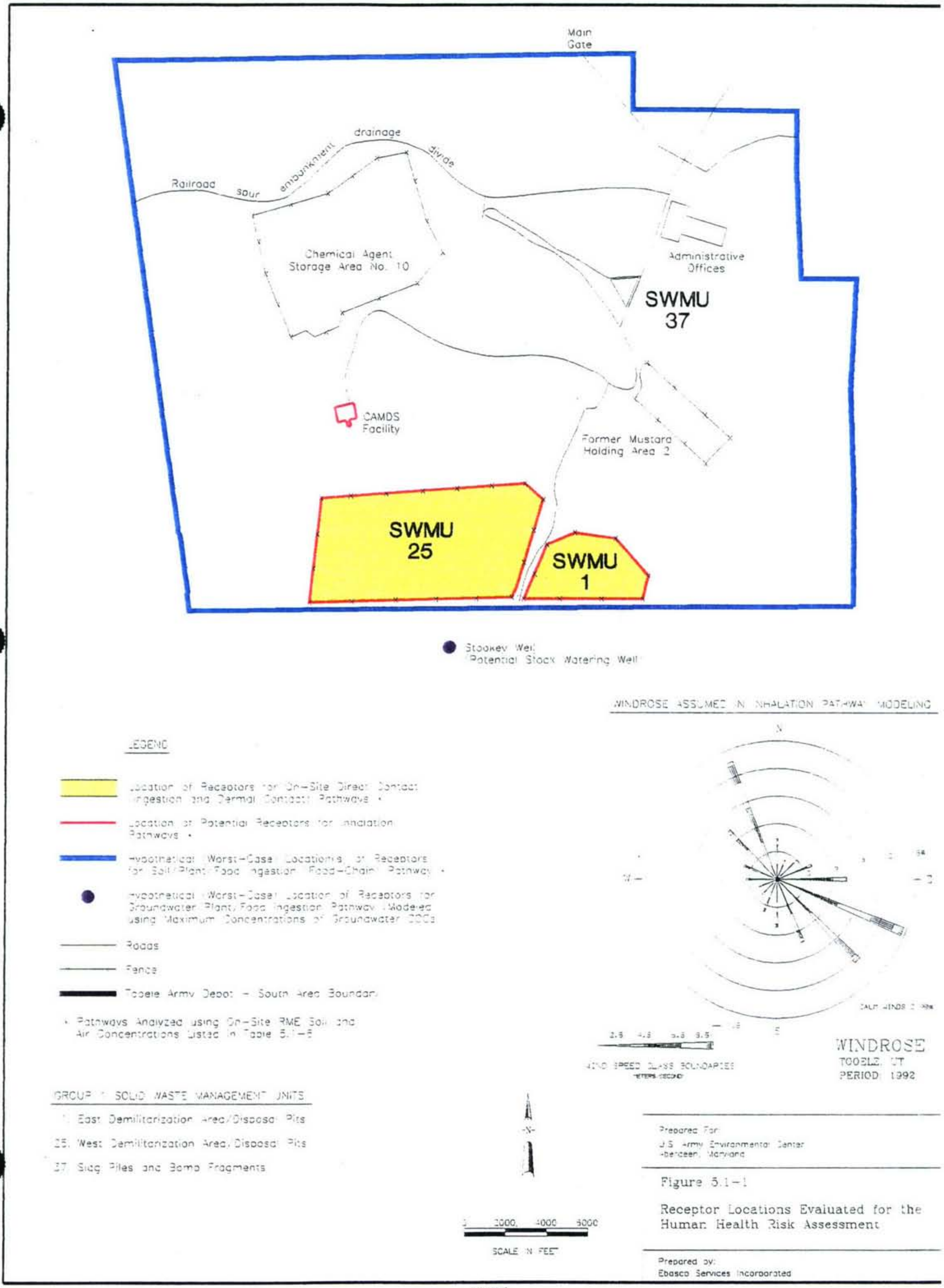

Figure 5.1-1

Receptor Locations Evaluated for the Human Health Risk Assessment

CARCINOGENS

Soil Ingestion

CDI = **CS** (mg/kg) x **10^{-6}** (kg/mg) x **SIR** (mg/day) x **1/BW** (kg) x (**# days/365 days**) x (**# years/70 years**)

Dermal Contact with Soils

CDI = **CS** (mg/kg) x **10^{-6}** (kg/mg) x **AF** (mg/cm^2) x **SA** (cm^2) x **ABS/BW** x (**# days/365 days**) x (**# years/70 years**)

Inhalation of Resuspended Soil Particulates

CDI = **CA** (mg/m^3) x **IR** (m^3/days) x **ET** (hours/day) x (**# days/365 days**) x (**# yrs/70 yrs**) x **1/BW**(kg)

NONCARCINOGENS

Chronic daily intakes (CDIs) for noncarcinogens are calculated in the same manner as that used for carcinogens (above) with one exception: intakes are not averaged over a 70 year lifetime. That is, the last term in the equation (# years/70 years) is excluded to account for toxic (noncarcinogenic) effects associated with shorter than lifetime exposures to COCs.

DEFINITIONS

COC	Chemical of concern
CDI	Chronic daily intake (mg/kg/day)
CS	COC concentration in soil (mg/kg)
CW	COC concentration in groundwater (mg/L)
10^{-6}	Unit correction factor (kg/mg)
SIR	Soil ingestion rate (mg/day)
BW	Body weight (kg)
AF	Soil adherence factor (mg/cm^2)
SA	Skin surface area exposed (cm^2)
ABS	Dermal absorption rate (unitless)
PM_{10}	Mean annual concentration of respirable particulates (<10 μm in diameter)
IR	Inhalation rate (m^3/hour)
ET	Exposure time (hours/day)
PEF	Particulate emissions factor (m^3/kg)
GIR	Groundwater ingestion rate (L/day)

NOTE:
Table 5.1-7 summarizes human exposure parameters used as input to the above equations. Soil and air EPCs used to calculate CDIs are listed in Table 5.1-8.

Table 5.1-7 Assumptions Used to Evaluate Future Residential Exposures to TEAD-S Surface Soil COCs

PARAMETER	RECEPTOR		SOURCE/ASSUMPTIONS
	Security Personnel	CAMDS Worker	
General Exposure Parameters			
Age During Exposure	Adult	Adult	-
Average Body Weight	70 kg	70 kg	EPA 1991a.
Lifetime Exposure Duration	25 years	25 years	EPA 1991a.
Soil Ingestion Parameters			
Exposure Frequency	24 days/year	NA	Professional judgment; conservatively assumes workers access SWMUs twice per month.
Soil Ingestion Rate	100 mg/day	NA	EPA 1991a.[1]
Dermal Contact Exposure Parameters			
Exposure Frequency	24 days/year	NA	EPA 1991a; professional judgment
Soil Adherence Rate	1.0 mg/cm^2	NA	EPA 1992c.
Surface Area Exposed	4,100 cm^2	NA	EPA 1985, 1992c; assumes hands, forearms, head, and neck exposed.
Dermal Absorption Rate	Metals: 0.1%	NA	EPA 1992c; professional judgment
Inhalation Exposure Parameters			
Frequency	250 days/year	200 days/year	EPA 1991a; professional judgment
Hours per Day	0.5	10	Professional judgment.
Respiratory Volume	2.5 m^3/hour	2.5 m^3/hour	EPA 1991a; assumes moderate activity for both receptor groups.

Notes:

B2EHP Bis(2-ethylehexyl)phthalate

1 Although EPA guidance (1991a) recommends a soil ingestion rate of 50 mg/day for workers, a more conservative value of 100 mg/day is used in this assessment to account for the potentially higher exposures possible at TEAD-S given its typically dusty environment.

References.

EPA :991a. Standard Default Exposure Factors.

EPA 1992c. Dermal Assessment Guidance.

EPA 1985. Development of Statistical Distributions of Ranges of Standard Factors Used in Exposure Assessment. Prepared by GCA Corp. Chapel Hill, N.C. EPA/600/8-85/010.

kg	kilogram	mg/cm^2	milligrams per square centimeters
cm^2	centimeters squared	m^3/hour	meters cubed per hour
%	percent	days/year	days per year
mg/day	milligrams per day		

5.1.2.3 Exposure Point Concentrations

Soil Exposure Point Concentrations

An exposure point concentration (EPC) is the chemical concentration to which an individual is assumed to be exposed. Table 5.1-8 lists the soil and air EPCs used to calculate direct contact (soil ingestion and dermal contact) and inhalation pathway risks for SWMUs 1 and 25, and inhalation pathway risks for CAMDS workers.

In accordance with EPA guidance (1991a), soil EPCs used in the risk assessment are the 95 percent upper confidence limit (UCL) of the arithmetic mean surface soil concentration calculated for each SWMU-specific COC. These EPCs are considered to represent reasonable maximum exposure (RME) estimates and were calculated after substituting values equal to one-half the detection limit for all nondetections in the database. The soil EPCs listed in Table 5.1-8 were used to calculate risks for both current and hypothetical future use soil exposure pathways. In accordance with EPA Region VIII protocols, this analysis assumes that 10 percent of the detected (total) chromium is in the hexavalent form; the remaining 90 percent is assumed to be trivalent. As discussed in Section 5.1.4.3 (Identification of Uncertainties), this assumption is likely to be conservative.

Air Exposure Point Concentrations

Using the soil EPCs defined above, screening level estimates of COC concentrations in airborne (resuspended) soil particulates were calculated for the three receptor locations defined in Section 5.1.2.1 (SWMU 1 fenceline, SWMU 25 fenceline, and CAMDS). The approach used to estimate COC concentrations in air is described in detail in Appendix K; a brief summary is provided here.

The Industrial Source Complex Short Term (ISCST2) Dispersion Model was used to predict 24-hour maximum and annual ambient air concentrations for receptors located at the SWMU 1 fenceline, the SWMU 25 fenceline, and CAMDS. The results of dispersion modeling were scaled for each COC by multiplying the ISCST2-generated dispersion coefficient by the SWMU-specific soil EPC estimate and the estimated fugitive dust emission rate to yield a conservative ambient air concentration estimate. Detailed documentation supporting the air modeling estimates is provided in Appendix K.

Table 5.1-8 Summary of Exposure Point Concentrations for TEAD-S Soil Exposure Pathways

	SWMU 1		CAMDS	SWMU 25		CAMDS
Chemical of Concern (COC)	Soil EPC (µg/g)	Air EPC (mg/m^3)	Air EPC (mg/m^3)	Soil EPC (µg/g)	Air EPC (mg/m^3)	Air EPC (mg/m^3)
Aluminum	29,110	1.8E-03	1.4E-05	28,859	3.8E-03	6.3E-05
Antimony	--	--	--	21.0	2.7E-06	4.6E-08
Arsenic	16.1	1.0E-06	7.6E-09	--	--	--
Barium	2,357	1.5E-04	1.1E-06	6,326	8.2E-04	1.4E-05
Beryllium	0.65	4.1E-08	3.1E-10	0.69	9.0E-08	1.5E-09
Cadmium	15.1	9.5E-07	7.1E-09	1.86	2.4E-07	4.1E-09
Chromium III	341	2.2E-05	1.6E-07	311	4.0E-05	6.8E-07
Chromium VI	37.9	2.4E-06	1.8E-08	34.6	4.5E-06	7,6E-08
Chromium (Total)	379	2.4E-05	1.8E-07	346	4.5E-05	7.6E-07
Copper	574	3.6E-05	2.7E-07	787	1.0E-04	1.7E-06
Cyanide (Total)	0.85	5.4E-08	4.0E-10	3.71	4.8E-07	8.1E-09
Lead	144	9.1E-06	6.8E-08	147	1.9E-05	3.2E-07
Manganese	614	3.9E-05	2.9E-07	621	8.1E-05	1.4E-06
Mercury	0.05	3.2E-09	2.4E-11	0.07	9.1E-09	1.5E-10
Nickel	50.5	3.2E-06	2.4E-08	47.4	6.2E-06	1.0E-07
Silver	1.13	7.1E-08	5.3-10	3.37	4.4E-07	7.4E-09
Thallium	25.7	1.6E-06	1.2E-08	26.2	3.4E-06	5.7E-08
Vanadium	23.9	1.5E-06	1.1E-08	30.1	3.9E-06	6.6E-08
Zinc	1,798	1.1E-04	8.5E-07	226	2.9E-05	4.9E-07

1 Soil EPCs are the 95% upper confidence limit (UCL) of the mean surface soil concentration calculated for each SWMU. These EPCs, considered to represent reasonable maximum exposure (RME) estimates, were calculated assuming nondetections are equal to one-half the method detection limit value. Air EPCs were estimated using the methods and assumptions described in Appendix K.

2 For each SWMU, potential inhalation risks to offsite receptors were evaluated for CAMDS, which was identified as the worse-case receptor location (i.e., modeled soil COC concentrations were highest at this location; see Appendix K).

-- Not applicable (constituent not a COC for that SWMU).

Note: In accordance with EPA Region VIII protocols, this analysis assumes that 10% of the detected (total) chromium is in the hexavalent form; the remaining 90% is assumed to be trivalent.

Table 5.1-8 Summary of Exposure Point Concentrations (EPCs) for TEAD-S Soil Exposure Pathways

	SWMU 1		CAMDS	SWMU 25		CAMDS
Chemical of Concern (COC)	Soil EPC (µg/g)	Air EPC (mg/m^3)	Air EPC (mg/m^3)	Soil EPC (µg/g)	Air EPC (mg/m^3)	Air EPC (mg/m^3)
Aluminum	29,110	1.8E-03	1.4E-05	28,859	3.8E-03	6.3E-05
Antimony	--	--	--	21.0	2.7E-06	4.6E-08
Arsenic	16.1	1.0E-06	7.6E-09	--	--	--
Barium	2,357	1.5E-04	1.1E-06	6,326	8.2E-04	1.4E-05
Beryllium	0.65	4.1E-08	3.1E-10	0.69	9.0E-08	1.5E-09
Cadmium	15.1	9.5E-07	7.1E-09	1.86	2.4E-07	4.1E-09
Chromium III	341	2.2E-05	1.6E-07	311	4.0E-05	6.8E-07
Chromium VI	37.9	2.4E-06	1.8E-08	34.6	4.5E-06	7.6E-08
Chromium (Total)	379	2.4E-05	1.8E-07	346	4.5E-05	7.6E-07
Copper	574	3.6E-05	2.7E-07	787	1.0E-04	1.7E-06
Cyanide (Total)	0.85	5.4E-08	4.0E-10	3.71	4.8E-07	8.1E-09
Lead	144	9.1E-06	6.8E-08	147	1.9E-05	3.2E-07
Manganese	614	3.9E-05	2.9E-07	621	8.1E-05	1.4E-06
Mercury	0.05	3.2E-09	2.4E-11	0.07	9.1E-09	1.5E-10
Nickel	50.5	3.2E-06	2.4E-08	47.4	6.2E-06	1.0E-07
Silver	1.13	7.1E-08	5.3-10	3.37	4.4E-07	7.4E-09
Thallium	25.7	1.6E-06	1.2E-08	26.2	3.4E-06	5.7E-08
Vanadium	23.9	1.5E-06	1.1E-08	30.1	3.9E-06	6.6E-08
Zinc	1,798	1.1E-04	8.5E-07	226	2.9E-05	4.9E-07

1 Soil EPCs are the 95% upper confidence limit (UCL) of the mean surface soil concentration calculated for each SWMU. These EPCs, considered to represent reasonable maximum exposure (RME) estimates, were calculated assuming nondetections are equal to one-half the method detection limit value. Air EPCs were estimated using the methods and assumptions described in Appendix K.

2 For each SWMU, potential inhalation risks to offsite receptors were evaluated for CAMDS, which was identified as the worse-case receptor location (i.e., modeled soil COC concentrations were highest at this location; see Appendix K).

-- Not applicable (constituent not a COC for that SWMU).

Note: In accordance with EPA Region VIII protocols, this analysis assumes that 10% of the detected (total) chromium is in the hexavalent form; the remaining 90% is assumed to be trivalent.

Groundwater Exposure Point Concentrations

For the current food-chain exposure scenario, two sets of groundwater EPCs were used to calculate risks—the maximum concentration listed in Table 5.1-3 (representing a worst-case scenario), and the 95 percent upper confidence limit (UCL) of the mean groundwater COC concentration. The 95 percent UCL values are considered to represent reasonable maximum exposure (RME) estimates in accordance with EPA guidance (1991a), and were calculated after substituting values equal to one-half the detection limit for all nondetections in the database. These RME values were also used to calculate groundwater exposure risks for the hypothetical residential future-use scenario.

Exposure Point Concentrations Used to Evaluate Agricultural (Food-Chain) Pathways

Appendix M.2 details the equations and assumptions used to quantify exposures for the groundwater/plant/food-ingestion and soil/plant/food-ingestion pathways described in Table 5.1-5. As described above, groundwater EPCs used as input in these equations are the 95 percent UCL (RME) and maximum concentrations of groundwater COCs. Soil EPCs used as input in these equations are the RME values listed in Table 5.1-8.

5.1.3 Toxicity Assessment

For risk assessment purposes, COCs are separated into two categories of chemical toxicity: carcinogenic and noncarcinogenic effects. As defined below, this distinction assumes the biological mechanism of action for each category is different. Tables 5.1-9 through 5.1-12 list toxicity values developed for noncarcinogenic and carcinogenic COCs. These values were combined with CDIs defined in Section 5.1.2 to calculate risks using the methods described in Section 5.1.4. Toxicity profiles for the COCs are provided in Appendix L.

5.1.3.1 Toxicity Information for Potential Carcinogenic Effects

As described in EPA guidance (1989d), a small number of molecular events can cause changes in a single cell or a small number of cells that can lead to tumor formation. This mechanism is described as no-threshold because it is assumed that there is no threshold level of exposure to a carcinogen that will not result in some finite possibility of causing the disease. Evaluation of carcinogenic effects is a two-step process involving weight-of-evidence determination and calculation of slope factors. These steps are described below.

Weight-of-evidence classifications are assigned to account for the likelihood that an agent is a human carcinogen. Using this system, chemicals are classified as either Group A, Group B1,

Table 5.1-9 Oral Cancer Parameters for TEAD-S COCs

Chemical	Ingestion Cancer Slope Factor $(mg/kg/day)^{-1}$	Weight-of-Evidence Classification	Type of Cancer (Species)	Source
Inorganics				
Aluminum	NA	D		(M1)
Antimony	NA			
Arsenic *	1.75E+00	A	Lung, skin (human)	(1)
Barium	NA			
Beryllium	4.3E+00	B2	Osteosarcoma (rabbit)	(1)
Cadmium	NA	B1	Lung, tumors (human, rat, mouse)	(1)
Chromium (III)	NA			
Chromium (VI)	NA	A	Lung (human)	(1)
Cobalt	NA			
Copper	NA	D		(1)
Cyanide	NA	D		(1)
Lead	NA	B2	Kidney (mouse, rat)	(1)
Manganese	NA	D		(1)
Mercury	NA	D		(1)
Nickel **	NA	A	Lung and nasal (human), tumors (rat)	(1)
Selenium	NA	D		(1)
Silver	NA	D		(1)
Thallium ***	NA	D		(1)
Vanadium	NA			
Zinc	NA	D		(1)

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Table 5.1-9 Oral Cancer Parameters for TEAD-S COCs

Chemical	Ingestion Cancer Slope Factor $(mg/kg/day)^{-1}$	Weight-of-Evidence Classification	Type of Cancer (Species)	Source
Volatiles				
Carbon Tetrachloride	1.3E-01	B2	Hepatocellular carcinomas, hepatines (hamster, rat, mouse)	(1)
Chloroform	6.1E-03	B2	Several tumor types (mouse, rat)	(1)
Ethylbenzene	NA	D	NA	(1)
Methylene Chloride	7.5E-03	B2	Hepatocellular, bronchiolar, salivary gland, leukemia (mouse, rat)	(1)
Toluene	NA	D	NA	(1)

COC Chemical of Concern
NA Not available

Consistent with EPA Guidance (1992), the oral cancer slope factors are used for the dermal contact risk calculations, as well as for the soil and groundwater ingestion scenarios.

* For adults only. Derived from the drinking water unit risk of 5E-5. Assumed 70 kg body weight and water consumption of 2 liters/day.
** From the IRIS file for nickel subsulfide.
*** From the IRIS file for thallium sulfate.
(1) Integrated Risk Information System (EPA 1994).
(2) Superfund Health Risk Technical Support Center (EPA 1993).
(M1) EPA (1992d)

A Human carcinogen
B1 Probable human carcinogen, limited human data are available
B2 Probable human carcinogen, sufficient evidence in animals and inadequate or no evidence in humans
C Possible human carcinogen
D Not classifiable as to human carcinogenicity
E Evidence of noncarcinogenicity for humans

Table 5.1-10 Inhalation Cancer Parameters for TEAD-S COCs

Chemical	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Corresponding Slope Factor $(mg/kg/day)^{-1}$	Weight-of-Evidence Classification	Type of Cancer (Species)	Source
Inorganics					
Aluminum	NA				
Antimony	NA				
Arsenic	4.3E-03	1.5E+00	A	Lung, skin (human)	(1)
Barium	NA				
Beryllium	2.4E-03	8.4E+00	B2	Lung (rat, monkey)	(1)
Cadmium	1.8E-03	6.3E+00	B1	Lung, trachea, bronchus (human)	(1)
Chromium (III)	NA				
Chromium (VI)	1.2E-02	4.2E+01	A	Lung (human)	(1)
Cobalt	NA				
Copper	NA				
Cyanide	NA				
Lead	NA				
Manganese	NA				
Mercury	NA				
Nickel*	4.8E-04	1.7E+00	A	Lung and nasal (human), tumors (rat)	(1)
Selenium	NA				
Silver	NA				
Thallium	NA				
Vanadium	NA				
Zinc					

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Table 5.1-10 Inhalation Cancer Parameters for TEAD-S COCs

Chemical	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Corresponding Slope Factor $(mg/kg/day)^{-1}$	Weight-of-Evidence Classification	Type of Cancer (Species)	Source
Inorganics					
Aluminum	NA				
Antimony	NA				
Arsenic	4.3E-03	1.5E+00	A	Lung, skin (human)	(1)
Barium	NA				
Beryllium	2.4E-03	8.4E+00	B2	Lung (rat, monkey)	(1)
Cadmium	1.8E-03	6.3E+00	B1	Lung, trachea, bronchus (human)	(1)
Chromium (III)	NA				
Chromium (VI)	1.2E-02	4.2E+01	A	Lung (human)	(1)
Cobalt	NA				
Copper	NA				
Cyanide	NA				
Lead	NA				
Manganese	NA				
Mercury	NA				
Nickel*	4.8E-04	1.7E+00	A	Lung and nasal (human), tumors (rat)	(1)
Selenium	NA				
Silver	NA				
Thallium	NA				
Vanadium	NA				
Zinc					

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Table 5.1-10 Inhalation Cancer Parameters for TEAD-S COCs

Chemical	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Corresponding Slope Factor $(mg/kg/day)^{-1}$	Weight-of-Evidence Classification	Type of Cancer (Species)	Source
Volatiles					
Carbon Tetrachloride	1.5E-05	5.3E-02	B2	Hepatocellular carcinomas, hepatomas (hamster, rat, mouse)	(1)
Chloroform	2.3E-02	8.1E+01	B2	Several tumor types (mouse, rat)	(1)
Ethylbenzene	NA	NA	D	NA	(1)
Methylene Chloride	4.7E-07	1.6E-03	B2	Hepatocellular, bronchiolar, salivary gland, luekemia (rat, mouse)	(1)
Toluene	NA		D		

Note: [1]Unit risks are converted to slope factors assuming a 20 m^3/day inhalation rate, 70 kg body weight, and a factor of 1,000 for µg to mg unit conversion (overall factor of 3500).

COC Chemical of Concern
NA Not available
(1) Integrated Risk Information System (EPA 1994)

A Human carcinogen
B1 Probable human carcinogen, limited human data are available
B2 Probable human carcinogen, sufficient evidence in animals and inadequate or no evidence in humans
C Possible human carcinogen
D Not classifiable as to human carcinogenicity
E Evidence of noncarcinogenicity for humans

Table 5.1-11 Oral Reference Doses for TEAD-S COCs

Chemical	Ingestion RfD (mg/kg/day)	RfD Confidence Level	Critical Effects	Uncertainty Factor	Modifying Factor	Source
Inorganics						
Aluminum	1E+00	Medium	Decreased body weight	100		(M1)
Antimony	4E-04	Low	Reduced life span, disturbances in blood glucose, and cholesterol metabolism	1000	1	(1)
Arsenic	3E-04	Medium	Hyperpigmentation, keratosis and possible vascular complications	3	1	(1)
Barium	7E-02	Medium	Increased blood pressure	3	1	(1)
Beryllium	5E-03	Low	No adverse effects	100	1	(1)
Cadmium (in food)	1E-03	High	Significant proteinuria	10	1	(1)
Chromium (III)	1E+00	Low	No effects observed	100	10	(1)
Chromium (IV)	5E-03	Low	No effects observed	500	1	(1)
Cobalt	NA	NA	NA	NA	NA	(3)
Copper*	3.7E-02	NA	Gastrointestinal system irritation	NA	NA	(2)
Cyanide	2E-02	Medium	Weight loss, thyroid effects and myelin degeneration	100	5	(1)
Lead	NA					
Manganese (in food)	1.4E-01	Medium	No observed adverse effects	1	1	(1)
Mercury	3E-04	NA	Kidney effects	1000		(2)

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Table 5.1-11 Oral Reference Doses for TEAD-S COCs

Chemical	Ingestion RfD (mg/kg/day)	RfD Confidence Level	Critical Effects	Uncertainty Factor	Modifying Factor	Source
Nickel	2E-02	Medium	Decreased body and organ weights	300	1	(1)
Selenium	5E-03	High	Clinical selenosis	3	1	(1)
Silver	5E-03	Low	Argyria	3	1	(1)
Thallium**	8E-05	Low	No adverse effects	3000	1	(1)
Vanadium	7E-03	NA	None observed	100		(2)
Zinc	3E-01	Medium	47% decrease in erythrocyte, superoxide dismutase (ESOD)	3	1	(1)
Volatiles						
Carbon Tetrachloride	7E-04	Medium	Liver lesions	1000	1	(1)
Chloroform	1E-02	Medium	Fatty cyst formation in liver	1000	1	(1)
Ethyıbenzene	1E-07	Low	Liver and kidney toxicity	1000	1	(1)
Methylene Chloride	6E-02	Medium	Liver toxicity	100	1	(1)
Toluene	2E-01	Medium	Changes in liver, kidney weights	1000	1	(1)

COC Chemical of concern
NA Not available
mg/kg/day milligrams per kilogram per day
RfD Reference dose

Consistent with EPA Guidance (1992), the oral RfDs are used for the dermal contact risk characterizations, as well as for the soil and groundwater ingestion scenarios.
* For adults only. Derived from the drinking water standard of 1.3 mg/L. Assumed 70 kg body weight and water consumption of 2 L/day.
** From the IRIS file for thallium sulfate.
(1) Integrated Risk Information System (EPA 1994)
(2) Health Effects Assessment Summary Tables (EPA 1993)
(M1) EPA (1992d).

Table 5.1-12 Inhalation Reference Concentrations for TEAD-S COCs

Chemical	Inhalation Reference Concentration (mg/m^3)	Corresponding RfD (mg/kg/day)	RfC Confidence Level	Critical Effects	Uncertainty Factors	Modifying Factor	Source
Inorganics							
Aluminum	NA						
Antimony	NA						
Arsenic	NA						
Barium	5E-04	1.4E-04	NA	Fetotoxicity	1000		(2)
Beryllium	NA						
Cadmium	NA						
Chromium	NA						
Chromium (III)	NA						
Chromium (IV)	NA						
Cobalt	NA		NA	NA	NA	NA	(3)
Copper	NA						
Cyanide	NA						
Lead	NA		NA	NA	NA	NA	
Manganese	5E-05	1.4E-05	Medium	Impairment of neurobehavioral function	1000	1	(1)
Mercury	3E-04	8.6E-05	NA	Neurotoxicity	30		(2)
Nickel	NA						
Selenium	NA						

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Table 5.1-12 Inhalation Reference Concentrations for TEAD-S COCs

Chemical	Inhalation Reference Concentration (mg/m^3)	Corresponding RfD (mg/kg/day)	RfC Confidence Level	Critical Effects	Uncertainty Factors	Modifying Factor	Source
Silver	NA						
Thallium	NA						
Vanadium	NA						
Zinc	NA						
Volatiles							
Carbon Tetrachloride	NA						
Chloroform	NA						
Ethylbenzene	1E+00	3.5E+00	Low	Developmental toxicity	300	1	(1)
Methylene Chloride	3E+00	1.1E+01	NA	Liver toxicity	100		(2)
Toluene	4E-01	1.4E+00	Medium	Neurological effects	300	1	(1)

COC Chemical of concern
NA Not available
(1) Integrated Risk Information System (EPA 1994).
(2) Health Effects Assessment Summary Tables (EPA 1993).
(3) Federal Register. June 7, 1981. Vol. 53, No. 109. Occupational Safety and Health Administration. Page 21282.

Group B2, Group C, Group D, or Group E. Group A chemicals (human carcinogens) are agents for which there is sufficient evidence to support the causal association between human exposures and cancer. Group B1 and B2 chemicals (probable human carcinogens) are agents for which there is limited (B1) or inadequate (B2) evidence of carcinogenicity from human studies, but for which there is sufficient evidence of carcinogenicity from animal studies. Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and no human data. Group D chemicals, which are not classified as to human carcinogenicity, are agents for which data are inadequate to evaluate either animal or human carcinogenicity. Group E chemicals (evidence of non-carcinogenicity in humans) are agents for which there is evidence of no carcinogenicity in adequate human or animal studies. In this risk assessment, chemicals with weight-of-evidence classifications A, B, and C are considered carcinogens. Chemicals with unknown carcinogenicity (Class D) are treated as noncarcinogens.

Based on the weight-of-evidence determinations described above, EPA calculates a slope factor that quantitatively defines the relationship between dose and response. This factor is expressed in units of $(mg/kg/day)^{-1}$. Slope factors are derived from the results of human epidemiological studies or, in many cases, chronic animal bioassays. These animal studies are usually conducted using relatively high doses to detect possible adverse effects. Because humans are expected to be exposed to lower doses than those used in animal studies, animal data are adjusted by using mathematical models and applying an inter-species scaling factor to derive a comparable low-dose slope factor for humans. Therefore, the use of these slope factors typically results in an upper-bound estimate of the probability of an individual to develop cancer as a result of exposure to a given level of a potential carcinogen. Whereas the actual risks are not likely to be higher than risks estimated using these slope factors, they could be considerably lower.

Table 5.1-9 lists slope factors for the oral exposure pathway and related toxicity information developed for each carcinogenic COC. Table 5.1-10 provides this information for the inhalation exposure pathway.

5.1.3.2 Toxicity Information for Potential Noncarcinogenic Effects

For chemicals that cause noncarcinogenic effects, exposed organisms are assumed to have protective mechanisms that must be overcome before the toxic endpoint is manifested. This view holds that a range of exposures from just above zero to some finite threshold value can be tolerated by the organism without appreciable risk of an adverse effect (EPA, 1989d).

Health criteria for chemicals exhibiting noncarcinogenic effects are generally developed using reference doses (RfDs). The RfD, expressed in units of mg/kg/day, is an estimate of the daily exposure that a human population (including sensitive subpopulations) can sustain that is not likely to present an unacceptable risk of deleterious effects during a lifetime (EPA 1989d). RfDs are generally developed by the EPA RfD Work Group. Alternative sources include Health Effects Assessments (HEAs) and Office of Drinking Water criteria documents that support health-based drinking water standards. These values are usually derived from animal studies and, in some cases, from human studies involving occupational exposures. These experimental or epidemiological data are then adjusted using a range of uncertainty factors. The RfDs thereby provide a benchmark to which chemical intakes by other routes (e.g., via exposure to environmental media) may be compared. Table 5.1-11 lists the RfDs developed for noncarcinogenic effects of COCs for oral routes of exposure, and Table 5.1-12 lists the RfDs developed for inhalation exposure routes.

5.1.3.3 Toxicity Factors Used to Evaluate Dermal Route Exposures

In accordance with EPA guidance (1992), the oral slope factors listed in Table 5.1-9 were also used to calculate dermal exposure pathway risks. Oral slope factors were not adjusted for dermal exposures given the uncertainties in the contaminant-specific absorption data and the fact that adjustment using default absorption factors often yields anomalous results (e.g., the dermal pathway drives the calculation of risk for inorganic constituents). Similarly, the oral RfDs listed in Table 5.1-11 were also used to evaluate hazards associated with the dermal exposure route for noncancer endpoints.

5.1.3.4 Chemicals For Which No Toxicity Values Are Available

Currently, EPA toxicity factors are unavailable for lead. EPA (1991a) recommends using the Uptake Biokinetic (UBK) Model to predict blood lead levels in the most sensitive population (i.e., children 0 to 6 years old) exposed to lead in air, dust, and soil. However, given the age of the exposed population at this site (i.e., adult rather than child), the UBK model was not used in this evaluation. Rather, the on-site soil concentrations were compared to the EPA interim lead soil cleanup level of 500 to 1,000 ppm. EPA considers this level to be appropriate for sites characterized as residential, so use of this guidance to evaluate lead exposure by workers at SWMUs 1 and 25 is conservative.

Toxicity criteria are also unavailable for cobalt, which was also identified as a potential soil COC (Tables 5.1-1 and 5.1-2). The extent to which this COC can be addressed in the risk assessment is limited to the qualitative information provided in the toxicity profile (Appendix L).

5.1.4 Risk Characterization

This section presents the results of the quantitative risk assessment conducted for TEAD-S. Section 5.1.4.1 describes the mathematical methods used in the pathway-specific cancer risk and hazard index calculations, Section 5.1.4.2 presents the results of the risk assessment, and Section 5.1.4.3 describes the uncertainties inherent in the risk assessment process.

5.1.4.1 Risk Calculation Methodology

5.4.4.1.1 Risk Calculation Methodology for Current-Use Pathways

Carcinogenic Endpoints

Excess cancer risks associated with exposures to known or potentially carcinogenic COCs are calculated by multiplying the slope factor (SF) by the estimated average lifetime dose, or CDI. "Excess" cancer risks are risks in excess of the normal cancer "burden" in a population and represent the upper-bound probability that an individual exposed to a given level of contaminant over a lifetime will develop cancer as a result of those exposures. A 10^{-6} upper-bound excess lifetime cancer risk, for example, is an increase of 1 in 1 million in the probability that an exposed individual would develop cancer.

In equation form, risk is defined as follows:

$$\mathbf{Risk} = (\mathbf{SF}) * (\mathbf{CDI}) \qquad \mathbf{(5\text{-}1)}$$

where:
- Risk = A unitless probability that an individual will develop cancer attributable to the assumed exposure scenario
- SF = Slope factor, expressed in $(mg/kg/day)^{-1}$
- CDI = Chronic daily intake averaged over 70 years (mg/kg/day)

Noncarcinogenic Endpoints

Risks associated with noncarcinogenic chemicals are generally developed using RfDs (or HEAs; see Section 5.1.3.2). These criteria are estimates of the daily chemical exposures that present an acceptably low risk of adverse effects to an individual over a specified exposure duration. In the absence of any information on the specific chemical mixture in question, the mixture is assessed

by means of a hazard index (HI). The HI is defined as the sum of the ratios of the CDI to the RfD for each noncarcinogenic chemical, as in the following equation:

$$\mathbf{HI = CDI_1 / RfD_1 + CDI_2 / RfD_2 + ... CDI_i / RfD_i} \qquad \mathbf{(5\text{-}2)}$$

CDI_i = Chronic daily intake for the i^{th} chemical in mg/kg/day
RfD_i = Chronic reference dose for the i^{th} chemical in mg/kg/day

Any single chemical with an exposure level greater than the reference level would cause the HI to exceed unity, indicating potential health risks of concern. For multiple chemical exposures, the HI can exceed the 1.0 target criterion even if no single chemical exceeds its corresponding reference dose (RfD). However, the assumption of additivity reflected in the HI equation is most properly applied to compounds that induce the same effect by the same mechanism. Consequently, applying this equation to a mixture of compounds that are not expected to induce the same type of effects could overestimate the potential for adverse health effects.

5.1.4.1.2 Risk Calculation Methodology for Future-Use Pathways

Risks for hypothetical future-use pathways were calculated using risk-based screening levels (RBSLs). RBSLs are chemical- and medium-specific concentrations that are considered protective of human health given a defined set of exposure and toxicity assumptions. For carcinogens, RBSLs are defined as concentrations protective of human health at a cancer risk level of 10^{-6}. For noncarcinogens, RBSLs are defined as concentrations unlikely to pose adverse health effects based on a hazard index of 1.0. Table 5.1-13 lists the soil and groundwater RBSLs developed for Group 1 SWMU future-use evaluations.

The methods used to calculate risks using RBSLs are slightly different from those described in Section 5.1.4.1.1 for the current-use evaluations. However, the basic premise is the same in that both current- and future-use risk calculations incorporate CDI (dose) and toxicity (SF and/or RfD) parameters for multiple exposure routes. The reason for using this alternative (RBSL) approach to calculate future-use hazards and risks is twofold. First, because the exposure assumptions used in the risk calculations are the same for both SWMUs, it results in a more streamlined assessment (i.e., it eliminates redundancy in summarizing exposure assumptions and CDI/risk calculations). Second, it provides a worst-case screening level point of reference, against which observed chemical concentrations can be compared. The following paragraphs summarize the methods

Table 5.1-13 Summary of RBSLs for Soil and Groundwater: Hypothetical Residential Future-Use Pathways[1]

Chemical of Concern	Soil RBSL [2] (μg/g)	Groundwater RBSL (μg/l)
Aluminum	78,200	--
Antimony	31.3	14.6[4]
Arsenic*	0.97[4]	0.05[4]
Barium	5,480	2,560
Beryllium*	0.4[4]	--
Cadmium	78.2	--
Carbon tetrachloride*	--	0.22
Chloroform*	--	0.21
Chromium, hexavalent*	175	--
Chromium, total—assuming 10% is hexavalent*	1,750	--
Chromium, trivalent	78,200	--
Cobalt	No Tox Data	No Tox Data
Copper	2,900	--
Cyanide	1,560	--
Ethylbenzene	--	2,430
Lead	500 [3]	15[3,4]
Manganese	10,900	--
Mercury	23.5	--
Methylene chloride*	--	5.42
Nickel	1,560	--
Selenium	--	183
Silver	391	--
Thallium	6.3[4]	2.92
Toluene	--	7,300
Vanadium	548	256
Zinc	23,500	--

Notes:

[1] The equations and assumptions used to calculate the soil and groundwater RBSLs listed here are provided in Appendix Table M.3-1 through M.3-4. COCs followed by an asterisk represent constituents for which the soil and/or groundwater RBSL reflects the carcinogenic endpoint corresponding to a 10^{-6} risk level goal. Appendix Tables M.3-5 through M.3-7 present the results of corresponding residential future use risk calculations for SWMU-specific soil COCs (ingestion, dermal contact, and inhalation pathways only) and groundwater COCs.

[2] For soil COCs for which both carcinogenic and noncarcinogenic endpoints were evaluated, the soil RBSLs listed above are the lowest (most conservative) of the values derived for both endpoints. For example, the soil RBSL for arsenic reflects the carcinogenic endpoint (the noncarcinogenic RBSL is 23.5 μg/g). However, the RBSLs for cadmium and nickel reflect the noncarcinogenic endpoint. (The higher carcinogenic RBSLs for these compounds stem from the small contribution of inhalation pathway risks and/or low cancer slope factors.)

[3] No toxicity data are available for lead, precluding calculation of a soil RBSL. The value of 500 μg/g listed above represents the lower bound of the 500 to 1,000 ppm interim soil cleanup level range for total lead recommended by EPA for CERLA sites characterized as residential (EPA 1991). The 15μg/l groundwater RBSL listed above for lead is the MCL.

[4] The soil RBSLs listed above for arsenic, beryllium, and thallium are lower than corresponding background levels (27.3μg/g, 0.89 μg/g, and 49.9 μg/g, respectively). Therefore, any exceedances of risk-based criteria identified for these constituents should be interpreted with caution. Additionally, for arsenic, an RBSL of 9.7μg/g might be more appropriate than the 0.97μg/g (10^{-6} risk-based) value cited above, given the following conclusion drawn in a recent memorandum by the Administrator of the EPA: "The uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards by as much as an order of magnitude, relative to risk estimates associated with most other carcinogens" (IRIS 1994). For water COCs, the RBSLs listed above for antimony, arsenic, and lead are lower than corresponding background levels (65.8 μg/l, 420 μg/l, and 24 μg/l, respectively).

-- Not applicable or not evaluated.

used to develop RBSLs and calculate associated risks; Appendix M.3 provides supporting documentation.

RBSL Development

Soil RBSLs for carcinogenic and noncarcinogenic endpoints were calculated using the equations and assumptions presented in Appendix Tables M.3-1 and M.3-2, respectively. These equations incorporate factors that quantify the assumed intakes for soil ingestion, dermal absorption (semivolatile organic compounds only), and particulate inhalation pathways.

Appendix Tables M.3-3 and M.3-4 document the equations and assumptions used to calculate carcinogenic and noncarcinogenic groundwater RBSLs. These equations account for both water ingestion and vapor inhalation (VOCs only) exposures.

For both soil and groundwater pathways, the exposure and toxicity assumptions used to develop RBSL equations follow standard EPA guidance for residential exposures (EPA 1989b, 1991a). For example, soil RBSLs for carcinogenic endpoints were calculated assuming exposure of a 70-kilogram adult 350 days a year for 30 years and at a soil ingestion rate of 100 mg/day (Appendix Table M.3-1). Alternatively, soil RBSLs for noncarcinogenic endpoints were calculated assuming exposure of a 15-kilogram child at a soil ingestion rate of 200 mg/day (Appendix Table M.3-2). (Averaging time is not relevant for evaluation of noncarcinogenic endpoints). Groundwater RBSLs were calculated assuming the same exposure frequency and duration as that defined above for soil pathways, at a daily water ingestion rate of 2 liters per day (Appendix Tables M.3-3 and M.3-4).

Characterization of Cancer Risks and Noncancer HIs Using RBSLs

Cancer risks for the future-use pathway evaluations (excluding food-chain pathways) were calculated using the following equation:

$$Risk_i = \frac{EPC_i}{RBSL_i} * RL \qquad \textbf{(5-3)}$$

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where: $Risk_i$ = Cancer risk for contaminant i
EPC_i = Exposure point concentration for contaminant i (μg/g or μg/L)
$RBSL_i$ = Risk-based screening level for contaminant i (μg/g or μg/L)
RL = Reference risk level (10^{-6})

The 10^{-6} reference risk level included in this equation accounts for the fact that the RBSL term was originally calculated assuming a 10^{-6} risk level. This approach to calculating risk is basically equivalent to that used for the current-use evaluations, in that risk is estimated as the product of the exposure point concentration, the intake rate, and the cancer slope factor (Section 5.1.4.1.1, Equation 5-1). The term "1/RBSL * RL" in Equation 5-3 is equivalent to the product of the intake rate and the slope factor; thus the two approaches yield the same result. The total cancer risk for residential exposures is then calculated by adding the contaminant-specific risks.

As defined in Section 5.1.4.1 (Equation 5-2), noncancer HIs are calculated by summing the chemical-specific HQs. For the future-use risk evaluations, HQs are calculated by dividing the chemical-specific (soil or groundwater) EPC by the RBSL (i.e, the chemical concentration for which no adverse health effect is anticipated). An HQ is computed separately for each COC as shown below (Equation 5-4):

$$HQ_i = \frac{EPC_i}{RBSL_i} \qquad \textbf{(5-4)}$$

Where: HQ_i = Hazard quotient for chemical i
EPC = Exposure point concentration for chemical i (μg/g or μg/L)
$RBSL_i$ = Risk-based screening level for chemical i (μg/g or μg/L)

This calculation is equivalent to calculating an HQ as the ratio of the chronic daily intake rate to the reference dose (Equation 5-2). The total (additive) noncancer health threat is then estimated by the hazard index, which is equal to the sum of the chemical-specific HQs.

5.1.4.1.3 Interpretation of Risk Assessment Results
Guidance specified in the State of Utah Hazardous Waste Management Rules (USHWCB 1994) states that the site management plan must contain procedures for corrective action if the level of risk present at a site is greater than 10^{-4} for carcinogens, or the hazard index is greater than 1 for

noncarcinogens. If the level of risk present at a site is less than 10^{-4} for the risk assessment conducted for <u>actual</u> or <u>potential</u> land use conditions (based on applicable zoning and future land use planning considerations), or greater than 10^{-6} for the risk assessment conducted for future residential uses, the site management plan may contain, but is not required to contain, procedures for corrective action. However, the site management plan in this case must include provision for site controls to limit exposure and must also include post-closure care. If the level of risk present at a site is below 10^{-6} for carcinogens and a hazard index of less than one for noncarcinogens, the site management plan may contain a no further action option.

Given the State of Utah guidelines cited above, this report defines cancer risk estimates between 10^{-6} and 10^{-4} as being within the range of risks requiring only site controls. This interpretation is similar to that which has been established by the EPA for the Superfund Program under the National Contingency Plan (NCP, 1990). This federal guidance states that the target risk range for carcinogens is a 10^{-6} to 10^{-4} incremental cancer risk, and that for noncarcinogens, where the HI exceeds unity (1.0), assumed exposures may present a health hazard and therefore warrant further evaluation.

As discussed in Section 5.1, because future residential use of TEAD-S is not anticipated, risk management decisions will be based on the results of the risk assessment conducted for current (actual) site conditions only.

5.1.4.2 Risk Assessment Results

This section presents the results of the human health risk assessment conducted for installation personnel and hypothetical local residents that have maximum exposure to COCs at Group 1 SWMUs at TEAD-S. Sections 5.1.4.2.1 and 5.1.4.2.2 quantify risks for the four (direct and indirect) SWMU-specific soil exposure pathways (SWMUs 1 and 25, respectively). These analyses assume that 10 percent of the total chromium detected in soil is in the hexavalent (carcinogenic) form; the remaining 90 percent is assumed to be trivalent (noncarcinogenic; Section 5.1.2.3). Section 5.1.4.2.3 quantifies risks for the two groundwater-related exposure scenarios identified in Table 5.1-5—the groundwater/plant/food-ingestion pathway associated with potential current or future uses, and potable and domestic uses of groundwater associated with hypothetical future residential use of TEAD-S. The appropriate risks for each receptor are then compared to State of Utah administrative rules for corrective action decision-making.

5.1.4.2.1 SWMU 1

Table 5.1-14 summarizes the cancer risks and noncancer hazard indices (HIs) calculated for current and potential future use soil exposure pathways at SWMU 1; these results are discussed below.

Current Use—Site Security (On-Post Worker Scenario)—Soil Exposure Pathway

The cancer risk and HI calculated for potential worker exposures to COCs in SWMU 1 soil are 2×10^{-6} and 0.094, respectively (Table 5.1-14). This scenario corresponds to intermittent soil ingestion and dermal contact exposures within SWMU 1 (2 days per month), and more frequent (250 days per year) inhalation exposures at the fenceline of the SWMU, for site security personnel (Table 5.1-5, Table 5.1-8). The 2×10^{-6} cancer risk estimate is within the 10^{-6} to 10^{-4} range of risks requiring site controls (Section 5.1.4.1.3), but is attributable primarily to background levels of arsenic via the soil ingestion pathway (Table 5.1-14, Note 3). The HI (0.094) is well below the corrective action HI criterion (1.0); hazard quotients (HQs) for manganese and thallium contribute most to this result.

Current Use—Off-Site CAMDS Receptor—Soil Inhalation Exposure Pathway

The cancer risk and HI calculated for potential worker inhalation exposures to SWMU 1 soil COCs at the downwind CAMDS location are 6×10^{-8} and 0.0055, respectively (Table 5.1-14). For this scenario, the analysis conservatively assumes that CAMDS workers inhale ambient particulates containing SWMU 1 soil COCs for 10 hours per day, 200 days per year, for 25 years; the entire particulate fraction is assumed to be respirable (Table 5.1-5, Table 5.1-8). Both the cancer risk and HI estimates are well below corresponding risk criteria (10^{-6} to 10^{-4} for carcinogens, and an HI of 1.0 for noncarcinogens). Hexavalent chromium accounts for the majority of the inhalation cancer risk; manganese and barium contribute most to the inhalation HI.

Potential Future Residential Agricultural Use—Farm Family Scenario—Soil Exposure Pathway

The cancer risk and HI calculated for the hypothetical future residential use exposure scenario are 8×10^{-5} and 9.8, respectively (Table 5.1-14). The 8×10^{-5} cancer risk estimate is within the 10^{-6} to 10^{-4} range of risks requiring only site controls (Section 5.1.4.1.3), and is attributable primarily to background levels of arsenic (via the produce consumption pathway). The HI of 9.8 exceeds the target HI criterion (1.0). However, this exceedance is not considered noteworthy (i.e., indicative of a potential health threat), given that background levels of thallium and arsenic account for the majority of the cumulative HI (Table 5.1-14, Note 3).

Table 5.1-14 Cancer Risks and Hazard Indices Calculated for SWMU 1 Soil Exposure Pathways[1,2]

	Exposure Pathway		Results of Cancer Risk (CR) Calculations		Results of Hazard Index (HI) Calculations	
Receptor Location	Pathway(s)	Scenario	CR	Driving COC(s) and Pathway	HI	Driving COC(s) and Pathway
Onsite[4]	SI/DC/INH (Appendix Table M.1-1)	Current (actual) site use	2×10^{-6}	arsenic (63%) and hexavalent chromium (28%); SI dominates (accounting for 63% of total risk); the majority of the CR is attributable to background levels of arsenic[3]	0.094	manganese (36%), thallium (33%), and barium (17%); SI and INH dominate, each accounting for 49% of the HI
CAMDS—downwind receptor	INH (Appendix Table M.1-3)	Current use	6×10^{-8}	hexavalent chromium accounts for 88% of the inhalation cancer risk	0.0055	manganese (72%) and barium (28%) account for the majority of the inhalation HI
Onsite	SI/DC/INH, and consumption of homegrown produce and animal products (Appendix Tables M.3-5, and M.2-3 through M.2-5)	Future residential/ agricultural use (farm family scenario)	8×10^{-5}	arsenic[3] accounts for the majority of the total CR; beryllium accounts for the remainder. Risks calculated for the SI/OC/INH (2×10^{5}), produce consumption (6×10^{-5}), and animal products consumption (2×10^{-6}) scenarios account for 25%, 75%, and <1% of the total cumulative risk, respectively	9.8	thallium and arsenic account for the majority of the HI[3]. HIs calculated for the SI/DC/INH (6.3), produce consumption (1.5), and animal products consumption (2.0) scenarios account for 64%, 15%, and 20% of the cumulative HI, respectively.

Note: All cancer risks listed above are within or below the lower bound of the 10^{-6} to 10^{-4} range of acceptable risks cited in State of Utah guidance (Section 5.1.4.1.3). For noncancer endpoints, the HI exceeds the target criterion of 1.0 for the future residential use pathway. However, this exceedance is considered attributable to background levels of thallium.[3]

COC - Chemical of concern
SI - Soil ingestion pathway
DC - Dermal contact pathway
INH - Inhalation pathway
CR - Cancer risk
HI - Hazard index

1 Appendix Tables M.1-1, M.1-3, M.2-3 through M.2-5, and M.3-5 provide detailed cancer risk and HI calculation documentation for the four SWMU 1 exposure scenarios summarized above. Tables 5.1-1 and 5.1-5 detail the COC and exposure pathway selection process, respectively. Cancer risks and HIs for all scenarios were calculated using the RME (95 percent UCL) concentrations of SWMU 1 soil COCs listed in Table 5.1-8.

2 Although lead was identified as a site-wide soil COC for SWMU 1, toxicity criteria are not available with which to quantify risks associated with soil ingestion and/or dermal contact exposures. Currently, as set forth by OSWER directive #9355.4-02, EPA recommends an interim soil cleanup level of 500-1,000 ppm total lead for sites characterized as residential (EPA, 1991b). Soil lead concentrations exceed the lower bound of this recommended range in only two samples— 01-SPDA-99 (1,100 µg/g) and 01-MSD-58 (990 µg/g), both located in the covered and open trenches (CAOT) area of SWMU 1. Lead concentrations in remaining soil samples are $\leq$360 µg/g.

[Note: The Uptake Biokinetic (UBK) Model, which is sometimes used to predict blood lead levels and derive corresponding soil lead cleanup levels for residential sites, was not applied in this assessment given that the underlying assumptions are not appropriate for current use scenarios at TEAD-S SWMUs since the model is recommended for estimating exposures to children under a residential use scenario. The UBK model was also not applied in the future residential use evaluation, given the hypothetical nature of this scenario.]

3 The results of the SWMU-wide risk assessment should be interpreted in light of the fact that the EPC used to calculate cancer risks and noncancer HQs for arsenic, 16.1 µg/g, is less than the 27.3 µg/g background level. This finding stems from the conservative assumptions used to identify COCs. As indicated in Table 5.1-1, arsenic concentrations exceed the 27 µg/g background level in only three samples— 01-IAM-13 (77 µg/g), located in the incendiary burning area; 01-HBA-93 (35 µg/g); and 01-SPDA-99 (33 µg/g).

Similarly, the soil EPC for thallium, 25.7 µg/g, is less than the 50 µg/g background level. The noncancer HI result calculated for the future-use soil exposure pathways should be interpreted in light of this finding. [Thallium was detected in only 3 of the 45 soil samples, 2 of which exceed background— 01-PCA-88 (73 µg/g) and 01-IA-60 (54 µg/g), both located in the CAOT area.] The soil EPC for beryllium, 0.65 µg/g, is also less than the corresponding 0.89 µg/g background level (Tables 5.1-1 and 5.1-8). [Beryllium exceeds background in only four samples, and by a negligible amount—1.15 µg/g, 0.97 µg/g, 0.91 µg/g, and 0.9 µg/g.]

4 The exposure point concentration used for the inhalation pathway is the value predicted by the air dispersion model to occur at the SWMU fenceline. The model cannot accurately predict concentrations within the source area.

5.1.4.2.2 SWMU 25

Table 5.1-15 summarizes the cancer risks and hazard indices (HIs) calculated for current and potential future use soil exposure pathways at SWMU 25; these results are discussed below.

Current Use—On-Site Worker (Site Security) Exposure Scenario—Soil Exposure Pathway

The cancer risk and HI calculated for potential worker exposures to COCs in SWMU 25 soil are 1×10^{-6} and 0.19, respectively (Table 5.1-15). This scenario corresponds to intermittent soil ingestion and dermal contact exposures within SWMU 25 (2 days per month), and more frequent (250 days per year) inhalation exposures at the fenceline of the SWMU for site security personnel. The 1×10^{-6} cancer risk estimate equals the lower bound of the 10^{-6} to 10^{-4} target risk range, which requires only site controls. This result is attributable primarily to hexavalent chromium via the inhalation pathway. The HI (0.19) is less than the target HI criterion (1.0); hazard quotients (HQs) for barium, manganese, and thallium contribute most to the HI.

Current Use—CAMDS Receptor—Soil Inhalation Exposure Pathway

The cancer risk and HI calculated for potential worker inhalation exposures to SWMU 25 soil COCs at the downwind CAMDS location are 2×10^{-7} and 0.037, respectively (Table 5.1-15). For this scenario, the analysis conservatively assumes that CAMDS workers inhale ambient particulates containing SWMU 25 soil COCs for 10 hours per day, 200 days per year, for 25 years; the entire particulate fraction is assumed to be respirable. Both the cancer risk and HI estimates are within the range of acceptable risks (less than 10^{-6} for carcinogens, and an HI less than 1.0 for noncarcinogens). Hexavalent chromium accounts for the majority of the inhalation cancer risk; manganese and barium contribute most to the inhalation HI.

Potential Future Residential/Agricultural Use—Farm Family Scenario—Soil Exposure Pathway

The cancer risk and HI calculated for the hypothetical future residential use exposure scenario are 5×10^{-6} and 9.6, respectively (Table 5.1-15). The 5×10^{-6} cancer risk estimate is within the 10^{-6} to 10^{-4} range of risks requiring only site control, and is attributable primarily to background levels of beryllium. The HI of 9.6 exceeds the target HI criterion (1.0), but is not considered noteworthy given that background levels of thallium account for the majority of the HI.

Table 5.1-15 Cancer Risks and Hazard Indices Calculated for SWMU 25 Soil Exposure Pathways[1, 2]

	Exposure Pathway		Results of Cancer Risk (CR) Calculations		Results of Hazard Index (HI) Calculations	
Receptor Location	Pathway(s)	Scenario	CR	Driving COC(s) and Pathway	HI	Driving COC(s) and Pathway
Onsite[5]	SI/DC/INH (Appendix Table M.1-2)	Current (actual) site use	1×10^{-6}	hexavalent chromium[3] (84%) and beryllium (11%); INH pathway accounts for 89% of total risk	0.19	barium (41%), manganese (36%), and thallium (17%); INH dominates, accounting for 74% of the HI; SI accounts for the remainder (26%)
CAMDS—downwind receptor	INH (Appendix Table M.1-4)	Current use	2×10^{-7}	hexavalent chromium accounts for 94% of the inhalation cancer risk	0.037	manganese (50%) and barium (50%)
Onsite	SI/DC/INH, and consumption of homegrown produces and animal products (Appendix Tables M.3-6, and M.2-6 through M.2-8)	Future residential use (farm family scenario)	5×10^{-6}	beryllium[4] accounts for the majority (>90%) of the total CR. Risks calculated for the SDC/INH (2×10^{-6}), produce consumption (3×10^{-6}) and animal products consumption (3×10^{-9}) account for 40%, 60%, and <1% of the total cummlative risk, respectively	9.6	thallium[4], barium, and antimony account for the majority of the HI. HIs calculated for the SI/DC/INH (6.9), produce consumption (0.82), and animal products consumption (1.9) account for 72%, 8%, and 20% of the cumulative HI, respectively

Note: All cancer risks listed above are within or below the lower bound of the 10^{-6} to 10^{-4} range of acceptable risks cited in State of Utah guidance (Section 5.1.4.1.3). For noncancer endpoints, the HI exceeds the target criterion of 1.0 for the future residential use pathway. However, this exceedance is considered attributable to background levels of thallium.[3]

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COC - Chemical of concern
SI - Soil ingestion pathway
DC - Dermal contact pathway
INH - Inhalation pathway
CR - Cancer risk
HI - Hazard index

1 Appendix Tables M.1-2, M.1-4, M.2-6 through M.2-8, and M.3-6 provide detailed cancer risk and HI calculation documentation for the SWMU 25 exposure scenarios summarized above. Tables 5.1-2 and 5.1-5 detail the COC and exposure pathway selection process, respectively. Cancer risks and HIs for all scenarios were calculated using the RME (95 percent UCL) concentrations of SWMU 25 soil COCs listed in Table 5.1-8.

2 Although lead was identified as a site-wide soil COC for SWMU 25, toxicity criteria are not available with which to quantify risks associated with soil ingestion and/or dermal contact exposures. Currently, as set forth by OSWER directive #9355.4-02, EPA recommends an interim soil cleanup level of 500-1,000 ppm total lead for sites characterized as residential (EPA, 1991b). The maximum soil lead concentration at SWMU 25, 410 µg/g (25-IBA-67), is less than the lower bound of this recommended range (also see Table 5.1-14, Note 2).

3 The cancer risk calculated for the current onsite exposure scenario, 1×10^{6}, reflects the conservative assumption that 10 percent of the total detected chromium is in the hexavalent form. The assumed background level of chromium (25 µg/g and 2.5 µg/g for total and hexavalent fractions, respectively) accounts for 6 percent of the total risk.

4 The results of the SWMU-wide risk assessment should be interpreted in light of the fact that the EPC used to calculate cancer risks and noncancer HQs for thallium, 26.2 µg/g, is less than the 50 µg/g background level. The noncancer HI result calculated for the future-use soil exposure pathways should be interpreted in light of this finding, which reflects the conservative assumptions used to identify COCs (Table 5.1-2). [Thallium was detected in 3 of the 21 soil samples, only one of which exceeds background (by a negligible amount— 25-IBA-65 (53 µg/g).] The soil EPC for beryllium, 0.69 µg/g, is also less than the corresponding 0.9 µg/g background level (Tables 5.1-2 and 5.1-8). [Beryllium exceeds background in only four samples, also by a negligible amount—1.28 µg/g, 1.0 µg/g, 0.92 µg/g, and 0.91 µg/g.]

5 The exposure point concentration used for the inhalation pathway is the value predicted by the air dispersion model to occur at the SWMU fenceline. The model cannot accurately predict concentrations within the source area.

5.1.4.2.3 Current and Future Use Groundwater Exposure Pathways

Table 5.1-16 summarizes the cancer risks and noncancer hazard indices (HIs) calculated for the (current and potential future use) groundwater/plant/food-chain exposure pathway and the potable/domestic groundwater use pathway developed for the hypothetical future residential use scenario. These results are discussed below.

Potential Current Use and/or Future Site Use Food Chain Exposure Pathway

Using maximum concentrations of groundwater COCs detected in TEAD-S wells (Table 5.1-3), the cancer risk and HI calculated for the potential groundwater/plant/food-ingestion pathway are 5×10^{-6} and 0.83, respectively (Table 5.1-16). This scenario represents a worst-case screening level analysis of potential human exposures to groundwater COCs through the food chain, in that it assumes that maximum concentrations of groundwater COCs in SWMU 1 and 25 wells are present at the same levels in the adjacent off-site (Stookey) stock watering well and concomitant ranching/grazing. Additionally, the analysis conservatively assumes that the farm family produces 75 percent of what it consumes from the beef and dairy product categories (Appendix Table M.2-1).

The 5×10^{-6} cancer risk estimate is well within the 10^{-6} to 10^{-4} range of risks requiring only site controls, and is attributable primarily to background levels of arsenic in groundwater (Table 5.1-16). The HI of 0.83 is less than the target HI criterion (1.0); the HQ for thallium accounts for most of the HI. Given the very conservative assumptions used in the groundwater/plant/food-chain modeling (e.g., on-site maximum groundwater concentrations were assumed to be present at an off-post (Stookey) well location), these results indicate no health threat posed by uptake of Group 1 SWMU groundwater COCs through the food chain (e.g., occurring via migration to off-post stock well watering locations).

The groundwater/plant/food-ingestion pathway discussed above was also modeled using RME (95 percent UCL) concentrations of groundwater COCs (Appendix Table M.2-2). The results of these calculations are lower than, but similar to, those derived using maximum groundwater COC concentrations—the cancer risk and HI estimates are 2×10^{-6} and 0.51, respectively (Table 5.1-16). Again, the cancer risk estimate is attributable primarily to background levels of arsenic.

Table 5.1-16 Cancer Risks and Hazard Indices Calculated for Groundwater-Related Exposure Pathways[1]

	Exposure Pathway		Results of Cancer Risk (CR) Calculations		Results of Hazard Index (HI) Calculations	
Receptor Location	Pathway(s)	Scenario	CR	Driving COC(s) and Pathway	HI	Driving COC(s) and Pathway
Offsite (e.g., Stookey well)—nearby farm residents	Food ingestion, via ground-water/plant/food-chain pathway (Appendix Table M.2-1)	Current (worst case scenario) and future use evaluation using maximum concentrations of groundwater COCs	5×10^{-6}	arsenic accounts for >99% of the food ingestion cancer risk—88% of the calculated risk (4.7×10^{-6}) is attributable to background concentrations of arsenic in groundwater (assuming a site-specific background level of 420 µg/l (Section 2.3))	0.83	thallium accounts for 91% of the food ingestion HI
Offsite—nearby farm residents	Food ingestion, same scenario described above (Appendix Table M.2-2)	Current (worst case scenario) and future use evaluation using RME (95% UCL) concentrations of groundwater COCs	2×10^{-6}	arsenic accounts for >99% of the food ingestion cancer risk; however, given that the (95% UCL) groundwater EPC for arsenic assumed in these calculations, 190 µg/l, is less than the 420 µg/l background level, all of this risk could be considered attributable to background	0.51	thallium accounts for 95% of the food ingestion HI
Onsite or downgradient shallow well locations	Ingestion, inhalation of volatile COCs while showering or washing (Appendix Table M.3-7)	Potable/domestic uses of groundwater associated with future residential site use[2]	4×10^{-3}	arsenic accounts for 99% of the total cancer risk, much of which is considered attributable to background levels of arsenic in groundwater (see comments for other groundwater pathway scenarios presented above)	53.0	thallium (54%), arsenic (33%), and antimony (13%) account for the majority of the HI—41% of the HI is attributable to background levels of arsenic (420 µg/l) and antimony (66 µg/l)

Table 5.1-16 Cancer Risks and Hazard Indices Calculated for Groundwater-Related Exposure Pathways[1]

Note: The cancer risks calculated for the worst-case (screening level) evaluation of potential current or future groundwater/plant/food-chain exposure pathways are well within the 10^{-6} to 10^{-4} range of risks requiring only site controls according to State of Utah administrative rules (Section 5.1.4.1.3). The cancer risk exceedance identified for hypothetical future residential uses of groundwater is attributable to background levels of arsenic. For noncancer endpoints, the HI target criterion of 1.0 is exceeded for the hypothetical future residential use pathway only.

COC - Chemical of concern
CR - Cancer risk
HI - Hazard index

1 Appendix Tables M.2-1, M.2-2, and M.3-7 provide detailed cancer risk and HI calculation documentation for the groundwater exposure scenarios summarized above. Tables 5.1-3 and 5.1-5 detail the COC and exposure pathway selection process, respectively. Cancer risks and HIs for all scenarios were calculated using the RME (95 percent UCL) or, for the worst-case groundwater/plant/food-ingestion food chain scenario, maximum groundwater COC concentrations.

2 Groundwater underlying SWMUs 1 and 25 is nonpotable (saline) give TDS levels and the guidelines stated in the Utah Groundwater Quality Protection Rules (Utah Administrative Code R317-6). However, Utah regulations require that the risk assessment evaluate potential exposures assuming the groundwater is potable (R315-101-5).

Potential Future Use—Farm Family—Groundwater Exposure Risks

The total cancer risk and HI calculated for groundwater exposures under a hypothetical future use scenario (i.e., potable and domestic uses) are 4 x 10^{-3} and 53, respectively (Table 5.1-16). These results were calculated using the groundwater RBSLs listed in Table 5.1-13; Appendix Table M.3-7 presents detailed (supporting) COC-specific risk calculations.

Both cancer and noncancer risk estimates exceed the 10^{-4} carcinogenic risk limit that would lead to site cleanup under Utah rules if this scenario corresponded to current use of TEAD-S. However, as this area is planned for continued use by Army industrial workers, not for residential development, this risk result will be used only for reference and will not cause corrective action at these SWMUs. However, as identified in Table 5.1-16, the majority of the total cancer risk is attributable to background levels of arsenic (420 µg/l) in groundwater, and 41% of the HI is attributable to background levels of arsenic and antimony (66 µg/l). The results of the future use groundwater pathway risk assessment should therefore be interpreted in light of these findings. Additionally, as identified in Table 5.1-5, future potable/domestic use of groundwater underlying SWMUs 1 and 25 is not expected, given that water quality standards are exceeded for sulfate, TDS, chloride, fluoride, and in many cases nitrate/nitrite.

5.1.4.3 Identification of Uncertainties

Risk assessment is an inexact but essential methodology used to characterize and quantitatively evaluate health effects potentially resulting from exposures to chemicals. The lack of explicitly relevant toxicity and exposure data, the uncertainty in chemical measurements in both the environment and the laboratory, and the need to extrapolate experimental endpoints to assumed human exposures and potential responses make precise quantification of risk difficult and inherently uncertain. For example, the assumptions used to calculate exposure rates and quantify potential health risks (described in Table 5.1-8 for soil exposure scenarios, and detailed in Appendix M for all pathways) are by nature imprecise because of variations in human behavior and physical characteristics. Given these unavoidable uncertainties, the general approach applied in this assessment was to develop conservative estimates of exposures, doses, and health risks. The major assumptions influencing risk estimates developed for TEAD-S Group 1 SWMUs are discussed below.

5.1.4.3.1 Exposure Point Concentration Determination

Soil EPCs

Many of the assumptions and models used to estimate human exposures and doses are associated with a high degree of uncertainty. For example, this assessment conservatively assumes exposures to a single, reasonable maximum (upper 95% confidence limit) chemical concentration in soil. However, individuals would more typically be exposed to a wide range of concentrations, resulting overall in a lower average exposure.

Soil Chromium EPCs

A factor that affects EPC estimates for both soil and air is the assumption that 10 percent of the total chromium detected in soil is in the hexavalent form; the remaining 90 percent is assumed to be trivalent (Section 5.1.2.3). Site-specific analytical data are not available to confirm the validity of this assumption. However, given the general and site-specific factors described below, the assumption regarding the valence state of chromium used in this analysis is considered conservative.

Chromium occurs in nature in two oxidation states—trivalent Cr(III) and hexavalent Cr(VI); both forms occur in a variety of naturally occurring minerals (Matzat and Shiraki 1972; Bartlett and James 1988). Consequently, the presence of chromium in soils does not necessarily connote an anthropogenic source. Most forms of Cr(III) present in soils, either as naturally occurring Cr, or as anthropogenic "contaminant" Cr, are low in solubility and reactivity, and are oxidized to Cr(VI) only under rather narrow and delicately balanced environmental circumstances (Bartlett and James 1988). This is due primarily to the overall chemical inertness of Cr(III) and its complexes, and to the high instability of Cr(VI) in soils (Bartlett and James 1988).

Factors which cause Cr(VI) to be highly unstable in the soil environment include, but are not limited to:

- The presence of oxidizable organic matter, oxidizable ferrous iron, and sulfides in soil
- Acid pHs
- The unavailability of Cr(III) (due to adsorption to soil surfaces), thus preventing its oxidation

5.1.4.3.1 Exposure Point Concentration (EPC) Determination

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Factors which cause Cr(VI) to be highly unstable in the soil environment include, but are not limited to:

- The presence of oxidizable organic matter, oxidizable ferrous iron, and sulfides in soil
- Acid pHs
- The unavailability of Cr(III) (due to adsorption to soil surfaces), thus preventing its oxidation

- The photoreduction of Cr(VI) by sunlight (Kieber and Helz 1992; Bartlett and James 1988; Calder 1988)
- The reduction of Cr(VI) by residual amounts of iron (Fe(II)) in weathering minerals, a phenomenon that is well documented (Eary and Rai 1989). (This finding is particularly relevant given the prevalence and magnitude of iron in TEAD-S soil.)

Moreover, soils that are dry for extended periods of time, such as the desert soils at Tooele, prevent the oxidization of Cr(III) to Cr(VI) (Bartlett and James 1988). For these reasons, it is believed that most, if not all, chromium added to soil soon becomes permanently established as Cr(III) (Bartlett and James 1988). An exception would be the presence of Cr as a component of stainless steel, where it is highly stable in a wide range of environments.

Air EPCs

The air emissions model used to estimate exposures to COCs in resuspended soil particulates is conservative, and makes many simplifying assumptions about site conditions, the physical/chemical processes that govern the airborne transport of soils containing COCs, and receptor locations and behavior. As described in Appendix K, estimates of ambient particulate concentrations in air were based upon typical storage pile emission rates. The COC concentrations in these particulates were assumed to be the same as the (RME) soil exposure point concentration estimates; the entire particulate fraction was assumed to be respirable. Consequently, predicted ambient air concentrations for each (fenceline and CAMDS) receptor represent conservative estimates for each COC. Moreover, the inhalation pathway modeling assumes that all windblown soil containing COCs constitute a respirable fraction of particulate matter (PM-10). However, as stated in EPA (1985b), the respirable fraction of dust emissions generated by wind erosion of exposed areas within an industrial facility might be approximately 50 percent. Therefore, the respirable fraction assumed in this analysis is likely to be overestimated by at least a factor of two.

Groundwater EPCs

The groundwater/plant/food-ingestion pathway was modeled assuming that maximum concentrations of groundwater COCs in SWMU 1 and 25 wells are present at the same levels in the adjacent off-site (Stookey) stock watering well. Essentially, the analysis conservatively assumes that maximum COC concentrations detected in wells screened proximate to the waste sources in SWMUs 1 and 25 are collocated at a single off-post (downgradient) location. However, if

migration of groundwater COCs has occurred (and no evidence exists that it has), such transport would have undergone attenuation by various mechanisms that would reduce concentrations reaching the Stookey well. As discussed in Section 4, COC concentrations detected in wells located along the southern perimeter of TEAD-S were highly variable, but generally low. [There is no evidence that the Stookey well is currently used for stock watering purposes, nor has the well been sampled to determine whether off-post migration has occurred.]

5.1.4.3.2 Human Exposure Parameter Estimation

Numerous uncertainties surround the determination of exposure parameters because the behavior patterns of individuals are not well known. For example, body weights, breathing rates, soil ingestion rates, and dermal contact rates are likely to vary depending on the actual characteristics of the exposed population. Given these uncertainties, reasonable maximum exposure (RME) values were used in the ingestion, dermal contact, and inhalation pathway calculations (Table 5.1-8, Appendix M).

5.1.4.3.3 Uncertainties Related to Toxicity Information

A number of uncertainties surround the use of slope factors, which serve as the basis for calculating estimated cancer risks. First, the development of slope factors assumes that the dose-response relationship is the same for both test animals and humans. Additionally, these factors represent upper-bound (95 percent upper confidence limit) estimates of potency. Thus, if an individual's exposure to a constituent is equivalent to the level that defines the potency, there is only a 5 percent chance that the actual risk to that individual will exceed the calculated risk, and a 95 percent chance that the risk is at or below the calculated level. Consequently, the actual risks associated with exposures to a potential carcinogen are not likely to exceed the risk estimated using these upper-bound slope factors, and in fact may be lower.

In accordance with EPA guidance (EPA 1992c), toxicity factors (slope factors and RfDs) derived from oral studies were also used to assess risks for dermal contact pathways. Oral toxicity factors were not adjusted for dermal exposures given the uncertainties in the chemical-specific absorption data and the fact that adjustment using default absorption factors often yields anomalous results. The uncertainty inherent in this approach must be acknowledged, however, as the risk associated with point-of-entry (skin) effects cannot be estimated directly from oral toxicity data. Unlike orally administered compounds, dermally applied chemicals would not undergo first-pass hepatic metabolism before reaching the systemic circulation. Therefore, a toxic effect attributable to an active metabolite might be more pronounced if the compound were

administered orally. Alternatively, the dermal absorption of a toxic parent compound that undergoes little or no first-pass metabolism might result in a greater dose of the toxic constituent entering the systemic circulation than if the compound were absorbed orally (EPA 1992c). Consequently, the application of oral toxicity factors to dermal pathway risk calculations represents a source of uncertainty in the risk assessment.

The lack of inhalation toxicity data for some COCs also contributes to the uncertainty of this evaluation. Inhalation reference concentrations (RfCs) and unit risks are not available for the following COCs—aluminum, antimony, copper, cyanide, lead, silver, thallium, vanadium, and zinc. Consequently, the inhalation risk and HI estimates for worker receptors may be underestimated in this respect. The extent of the potential underestimation is unknown. However, for carcinogens, the chemicals for which toxicity data are available—arsenic, beryllium, cadmium, chromium VI, and nickel—are likely to be the major contributors to the inhalation risks. Therefore, the lack of inhalation toxicity data for the remaining COCs is not expected to result in a significant underestimation of the inhalation cancer risk or HI estimates, particularly in light of the conservatism inherent in the emissions modeling (described above).

5.1.5 Conclusions of the Human Health Risk Assessment

Table 5.1-17 summarizes the results of the human health risk assessment conducted for Group 1 SWMUs at TEAD-S. Chemicals of concern (COCs) for soil and groundwater were identified using very conservative selection criteria. Eighteen soil COCs were evaluated, consisting of inorganic constituents only. With the exception of arsenic (SWMU 1 only) and antimony (SWMU 25 only), soil COCs were the same for both SWMUs. Eleven COCs were identified for groundwater, consisting of (six) inorganic and (five) organic constituents. Cancer risks and noncancer hazard indices (HIs) were calculated for both current use (TEAD-S worker and potential indirect groundwater exposure scenarios) and future use (hypothetical residential agricultural scenario) soil and groundwater exposure pathways. The major findings of the risk assessment are summarized as follows:

- Total cancer risks calculated for potential on-site worker exposures (site security personnel) to soil COCs at SWMUs 1 and 25 are 2×10^{-6} and 1×10^{-6}, respectively. These estimates are at the lower bound of the risk range (10^{-6} to 10^{-4}) requiring site controls as stated in State of Utah rules. Noncancer HIs are 0.094 and 0.19 for SWMUs 1 and 25, respectively; both estimates are less than the corrective action HI criterion of 1.0.

Table 5.1-17 Summary of Human Health Risk Assessment Results for Group 1 SWMU Exposure Pathways

Location/Source	Exposure Scenario Evaluated	Cancer Risk	Hazard Index	Comment(s)
CURRENT (ACTUAL) USE EXPOSURE PATHWAYS				
SWMU 1— Soil	- On-site worker exposures to soil COCs (ingestion/dermal contact/inhalation)	2×10^{-6}	0.094	Background levels of arsenic account for the majority (>60%) of the total cancer risk
	- Off-site inhalation exposures to SWMU 1 soil COCs at downwind CAMDS location	6×10^{-8}	0.0055	Results for both cancer and noncancer endpoints are well below target risk criteria [Soil lead concentrations exceed the lower bound of EPA's 500-1,000 ppm recommended range (EPA 1991b) in only two samples— 01-SPDA-99 (1,100 µg/g) and 01-MSD-58 (990 µg/g).]
SWMU 25— Soil	- On-site worker exposures to soil COCs (ingestion/dermal contact/inhalation)	1×10^{-6}	0.19	Both the cancer risk and the HI are at or below target risk criteria
	- Off-site inhalation exposures to SWMU 25 soil COCs at downwind CAMDS location	2×10^{-7}	0.037	Results for both cancer and noncancer endpoints are below target risk criteria [No exceedances of EPA's recommended 500-1,000 ppm soil lead level range were identified.]
Groundwater Underlying SWMUs 1 and 25	- Groundwater/plant/food-ingestion (food chain) pathway—assumes that maximum concentrations of groundwater COCs in SWMU 1 and 25 wells are present at the same levels in the adjacent off-site (Stookey) stock watering well and subsequent uptake into the food chain	5×10^{-6}	0.83	The food ingestion cancer risk is within the 10^{-6} to 10^{-4} target risk range—88% of the cancer risk is attributable to background (420 µg/l) concentrations of arsenic in groundwater. The noncancer HI is less than the target criterion of 1.0. [The cancer risk and HI calculated using RME (95% UCL) groundwater COC concentrations are 2×10^{-6} and 0.51, respectively.]

Table 5.1-17 Summary of Human Health Risk Assessment Results for Group 1 SWMU Exposure Pathways

Location/Source	Exposure Scenario Evaluated	Cancer Risk	Hazard Index	Comment(s)
FUTURE (HYPOTHETICAL RESIDENTIAL) USE EXPOSURE PATHWAYS				
SWMU 1— Soil	Future residential/agricultural use (farm family scenario)	8×10^{-5}	**9.8***	Background levels of arsenic account for the majority of the CR, and background levels of thallium and arsenic contribute most to the HI (which exceeds the 1.0 target HI criterion)
SWMU 25— Soil	Future residential/agricultural use (farm family scenario)	5×10^{-6}	**9.6**	The cancer risk is within the 10^{-6} to 10^{-4} range of acceptable risks, and is attributable primarily to background levels of beryllium. The HI exceeds the target HI criterion (1.0); however, background levels of thallium account for the majority of this result.
Groundwater Underlying SWMUs 1 and 25	Potable/domestic uses of groundwater associated with future residential site use—ingestion, inhalation of volatile COCs while showering or washing	$\mathbf{4 \times 10^{-3}}$	**53.0**	Arsenic accounts for 99% of the total cancer risk, much of which is considered attributable to background levels of arsenic in groundwater. Thallium (54%), arsenic (33%), and antimony (13%) contribute most to the noncancer HI—41% of the HI is attributable to background levels of arsenic and antimony

Note

Values listed in bold exceed corresponding risk criteria (e.g., a risk range of 10^{-6} to 10^{-4} for carcinogens, and an HI of 1.0 for noncarcinogens). In all cases, exceedances identified above are attributable primarily to background levels of COCs (namely, arsenic, thallium, and beryllium).

- Potential inhalation risks to off-site receptors were evaluated for each SWMU, assuming wind dispersal of particulates containing soil COCs to the downwind CAMDS facility location (Figure 5.1-1). Total cancer risks calculated for potential inhalation exposures to CAMDS workers are 6×10^{-8} and 2×10^{-7} (for SWMUs 1 and 25, respectively). Noncancer HIs are 0.0055 (SWMU 1) and 0.037 (SWMU 25). Results for both cancer and noncancer endpoints are well within acceptable risk criteria.

- A worst-case analysis of potential risks associated with uptake of groundwater COCs through the food chain was also evaluated, assuming that maximum concentrations of groundwater COCs in SWMU 1 and 25 wells are present at the same levels in the adjacent off-site (Stookey) stock watering well. The cancer risk and HI calculated for the groundwater/plant/food-ingestion pathway are 5×10^{-6} (attributable primarily to background levels of arsenic in groundwater) and 0.83, respectively. The carcinogenic risk result indicates that either site controls or monitoring are required under Utah rules. However, the actual presence and concentrations of SWMU 1 and 25 COCs in this well are unknown.

- Total cancer risks calculated for soil exposures under the future-use residential/agricultural (farm family) scenario are 8×10^{-5} and 5×10^{-6} for SWMUs 1 and 25, respectively. These estimates are within the (10^{-6} to 10^{-4}) range of risks requiring only site controls. As identified for other pathway scenarios, background levels of arsenic account for the majority of total cancer risk at SWMU 1. Noncancer HIs (9.8 and 9.6) exceed the target HI criterion (1.0) for both SWMUs—these exceedances are attributable primarily to background levels of thallium in soil and thus are not considered noteworthy.

- Groundwater in the shallow aquifer beneath SWMUs 1 and 25 is not used as a potable water source due to its salinity and low production capacity; these conditions are not expected to change in the future. Nonetheless, risks associated with potable/domestic use of groundwater were quantified for the hypothetical future residential use scenario. The cancer risk (4×10^{-3}) and noncancer HI (53.0) both exceed risk criteria requiring corrective action. Arsenic accounts for 99 percent of the total cancer risk, most of which

is attributable to background levels of arsenic in groundwater. Also, 41 percent of the HI is attributable to background levels of arsenic and antimony.

- The results of the future use risk evaluations should be interpreted in light of the hypothetical nature of the residential/agricultural use scenario and the extent to which background levels of COCs contribute to the cancer risk and HI estimates. Because future residential use of TEAD-S is not anticipated, the residential scenario was presented for comparison purposes only, and will not be used as the basis for any subsequent risk management decisions.

The results of all (current- and future use) risk evaluations summarized above are considered conservative given the assumptions used to estimate contaminant doses and human exposures, which include (but are not limited to) the following:

- Reasonable maximum assumptions for soil, air, and groundwater exposure point concentrations (EPCs)
- Worst-case (screening level) estimates of soil and groundwater COCs in the food chain (soil/plant/food-ingestion and groundwater/plant/food-ingestion) pathway modeling
- Reasonable maximum assumptions for human intake factors, including soil ingestion rates, dermal contact rates, and the exposure frequency and duration assumed for off-site (worker and agricultural) receptor scenarios

The results of the human health risk assessment indicate no potential health threats stemming from exposure to soil or groundwater COCs identified at TEAD-S Group 1 SWMUs under current (actual) site conditions. With the exception of the future groundwater use pathway, any exceedances of target risk criteria identified in the assessment were slight, and largely attributable to background levels of arsenic (soil and groundwater) and/or thallium (soil only).

5.1.6 Risk Based Corrective Action Levels Developed for Current (Actual) Site Conditions

In accordance with State of Utah RCRA guidance (USHWCB 1994), risk-based soil corrective action levels (SCALs), considered health-protective standards for current site uses, were developed for soil at TEAD-S Group 1 SWMUs. SCALs were calculated for all soil COCs using the same reasonable maximum exposure (RME) assumptions applied in the current use on-site worker exposure evaluation.

For carcinogenic COCs, SCALs essentially represent a back-calculation of pathway-specific risks (solving for the COC soil concentration term) to achieve a cancer risk level of 10^{-6}, the top of the range considered by the State of Utah to be generally acceptable (NCP, 1990). For noncarcinogens, action levels were calculated to achieve a hazard index (HI) of 1.0, considered to be a level of concern for potential adverse health effects. Because exposures and potential toxic effects differ according to the pathway evaluated, pathway-specific SCALs were initially calculated. A final soil action level was then developed to reflect all exposure routes.

Table 5.1-18 lists the SCALs developed for the current-use on-site worker exposure scenario. Sample-specific exceedances of SCALs were identified for three soil COCs—arsenic, chromium, and lead. Figure 5.1-2 plots sample-specific concentrations of these constituents *vis a vis* the SCALs listed in Table 5.1-18, the RBSLs developed for hypothetical residential site uses, and corresponding site-specific background levels. [Figure 5.1-2 also plots sample-specific concentrations of cadmium and thallium, given exceedances identified for the future-use pathway evaluations.] As shown in this figure, exceedances are generally limited to a few isolated sample locations, such as 01-IAM-13 (SWMU 1, IBA) and 01-PBA-55 (SWMU 1, CBA). The sample-specific results presented in Table 5.1-18 and Figure 5.1-2 should be evaluated in light of the following factors: (1) the SCAL for arsenic is lower than the corresponding background level; and (2) accounting for background contributions, cancer risks, and noncancer HIs calculated for the current use soil exposure pathways (using RME soil exposure point concentrations) are below corrective action risk criteria (Tables 5.1-14 and 5.1-15).

5.2 ECOLOGICAL RISK ASSESSMENT

5.2.1 Introduction

This ecological risk assessment (ERA) for SWMUs 1 and 25 is consistent with the draft version of the Framework for Ecological Risk Assessment (EPA 1992e) and the Supplemental Risk Assessment Guidance for the Superfund Program, Part II, Ecological Risk Assessment (EPA 1989d).

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5.2 ECOLOGICAL RISK ASSESSMENT

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Table 5.1-18 Risk-Based Soil Corrective Action Levels (SCALs) Developed for Current (Actual) Site Conditions at TEAD-S Group 1 SWMUs[1]

Chemical of Concern (site-specific background level)	SCAL— On-Site Worker Pathway	SWMU 1—No. of Sample-Specific Exceedances[2]	SWMU 25—No. of Sample-Specific Exceedances[2]
Aluminum (17,700 µg/g)	**	0	0
Antimony (Not Detected)	4,090	0	0
Arsenic (27.3 µg/g)	**16.1 (3)**	**9 (3)**	**2 (0)**
Barium (536 µg/g)	80,000	0	0
Beryllium (0.89 µg/g)	6.45	0	0
Cadmium (0.98 µg/g)	281	0	0
Chromium III	**	--	--
Chromium VI	42	--	--
Chromium—Total (25.1 µg/g)	**420**	**3 (19)**	**1 (16)**
Copper (25.1 µg/g)	379,000	0	0
Lead (34.8 µg/g)	**500[4]**	**2 (16)**	**0 (12)**
Manganese (658 µg/g)	8,950	0	0
Mercury (0.08 µg/g)	2,900	0	0
Nickel (19.5 µg/g)	1,037	0	0
Silver (0.44 µg/g)	51,100	0	0
Thallium (49.9 µg/g)	813	0	0
Vanadium (23.1 µg/g)	71,600	0	0
Zinc (104 µg/g)	**	0	0
Cyanide	205,000	0	0

Note: All units in µg/g (ppm). Sample-specific concentrations of bolded COCs are plotted in Figure 5.1-2 (given exceedances of corrective action levels identified above). [This figure also plots sample-specific distributions for cadmium and thallium, given that exceedences of the future-use pathway RBSLs were identified for these constituents.]

1 For soil COCs for which both carcinogenic and noncarcinogenic endpoints were evaluated, the SCALs listed above are the lowest (most conservative) of the values derived for both endpoints.

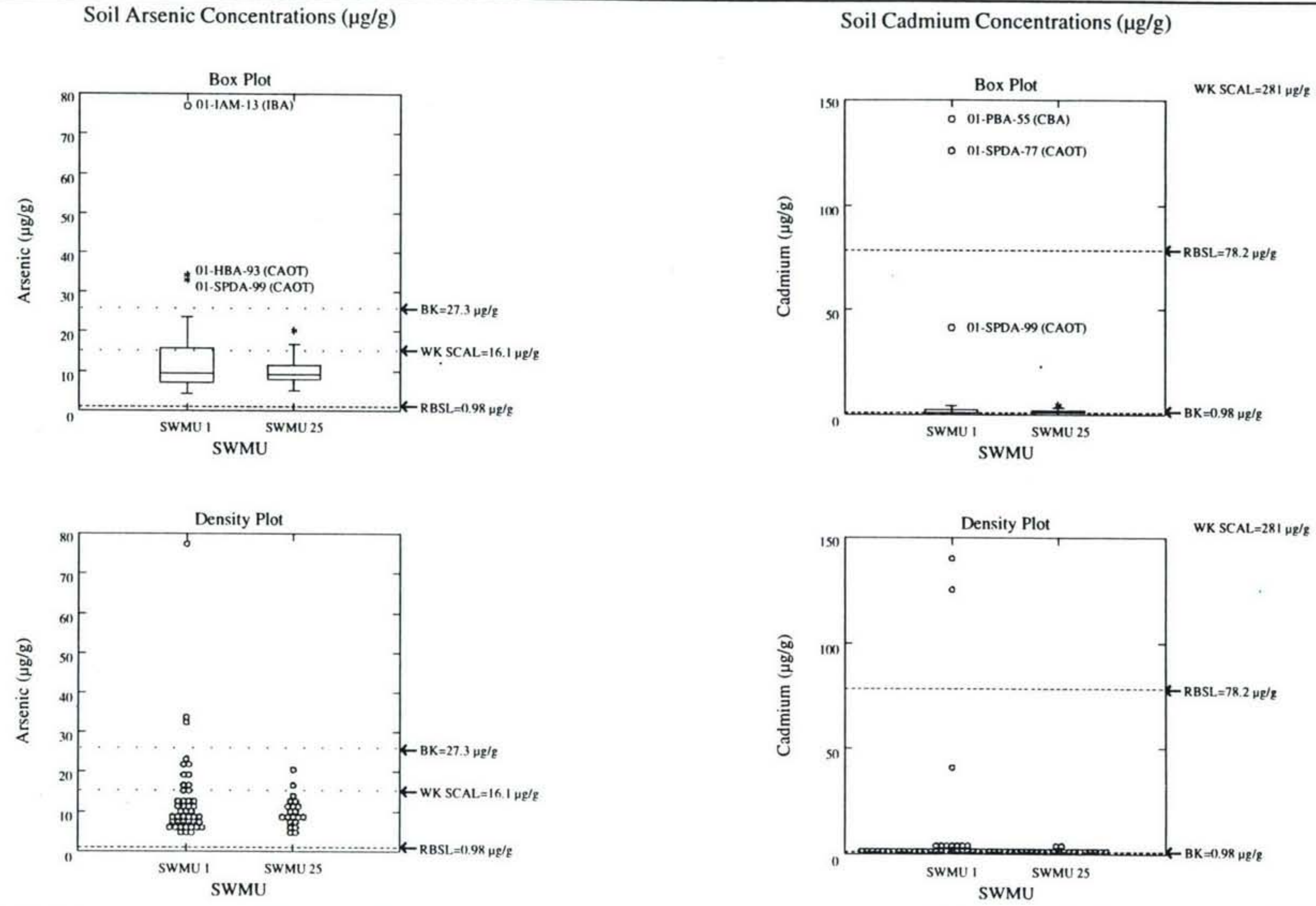
2 This column lists the number of detections exceeding the corresponding on-site worker SCAL. For those constituents for which exceedances were identified (arsenic, chromium, and lead), the number of detections exceeding background is noted in parentheses.

3 The corrective action level is less than the site-specific soil background level.

4 Value is the lower bound of EPA's 500-1,000 ppm interim soil cleanup level range for total lead (EPA 1991b).

** Level is greater than 10^6 µg/g, equivalent to exposure to pure compound at the assumed intake rates.

-- Not applicable or not determined.



Legend

WK SCAL	= Corrective Action Level for On-Site Worker Pathway
RBSL	= Risk-Based Screening Level for Hypothetical Residential Use Pathway
BK	= Site-Specific Background Level
CAOT	= Covered and Open Trenches
CBA	= Crate Burning Area
IBA	= Incendiary Burning Area

Figure 5.1-2 **1 of 4**

Plot of Sample-Specific Concentrations for Driving Soil COCs

Tooele

Prepared by: Ebasco Services Incorporated

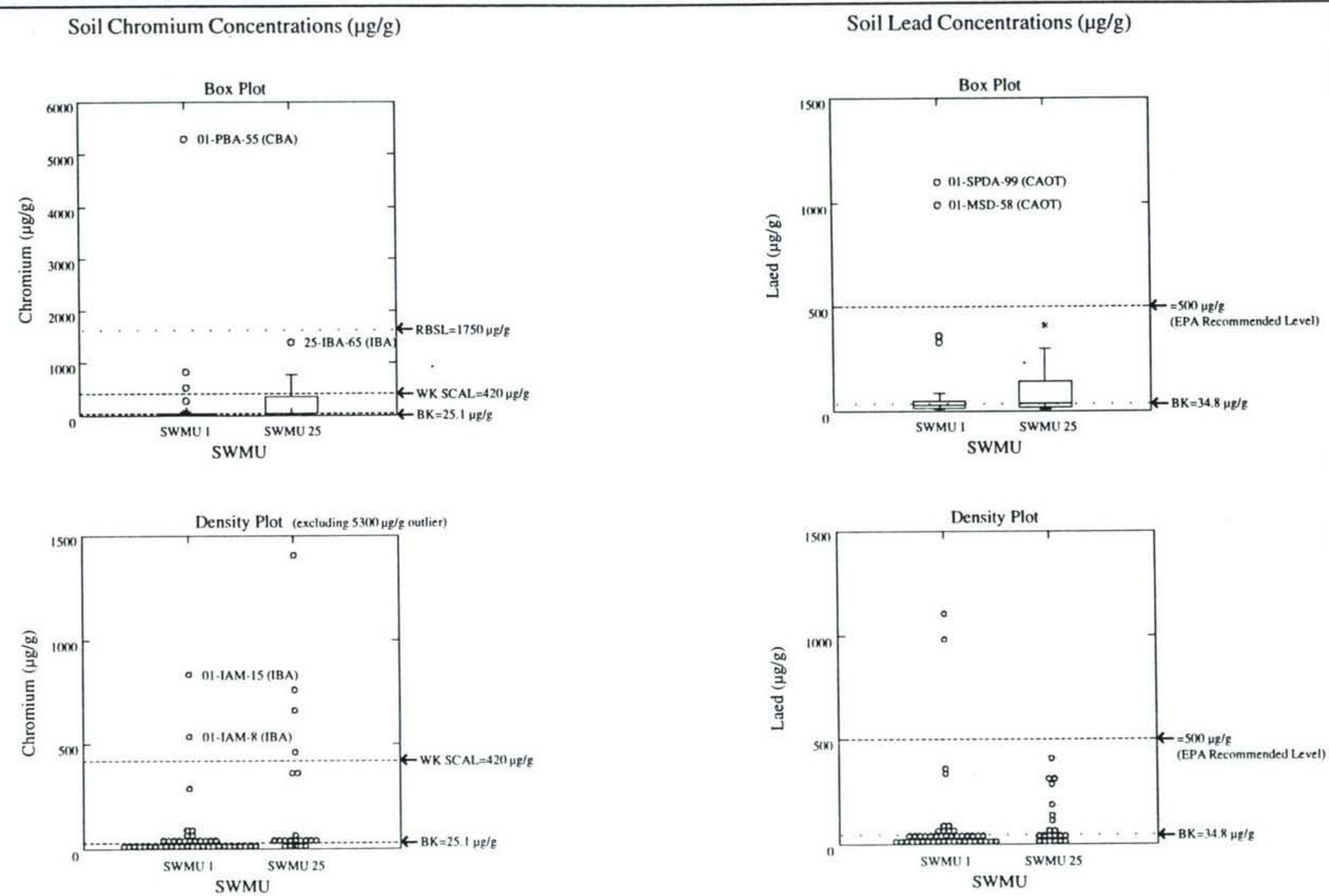


Figure 5.1-2 2 of 4

Plot of Sample-Specific Concentrations for Driving Soil COCs

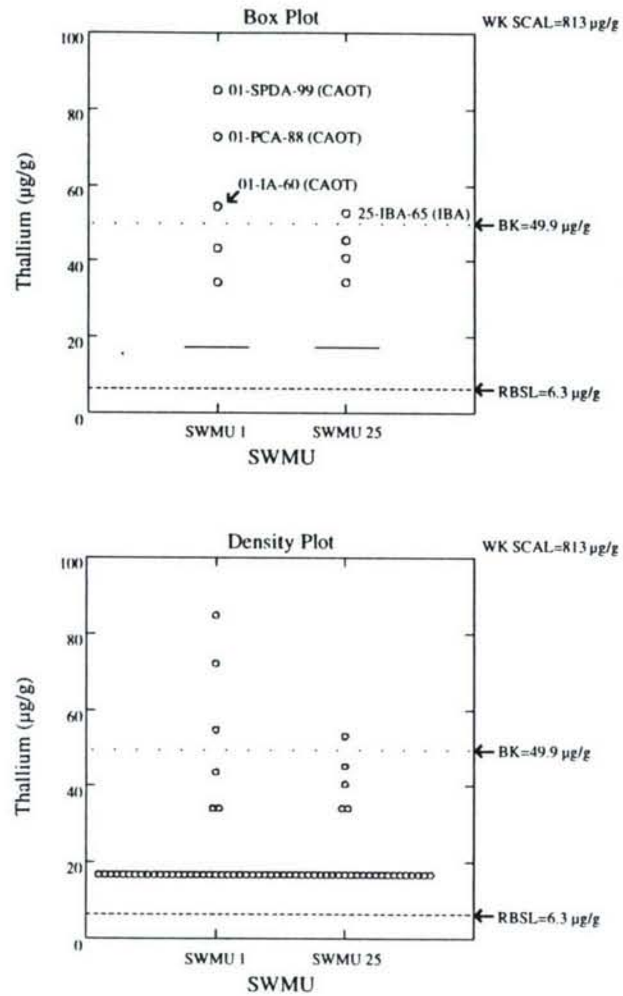
Tooele

Prepared by: Ebasco Services Incorporated

Legend

WK SCAL = Corrective Action Level for On-Site Worker Pathway
RBSL = Risk-Based Screening Level for Hypothetical Residential Use Pathway
BK = Site-Specific Background Level
CAOT = Covered and Open Trenches
CBA = Crate Burning Area
IBA = Incendiary Burning Area

Soil Thallium Concentrations (µg/g)



Legend

WK SCAL	= Corrective Action Level for On-Site Worker Pathway
RBSL	= Risk-Based Screening Level for Hypothetical Residential Use Pathway
BK	= Site-Specific Background Level
CAOT	= Covered and Open Trenches
CBA	= Crate Burning Area
IBA	= Incendiary Burning Area

Figure 5.1-2 **3 of 4**

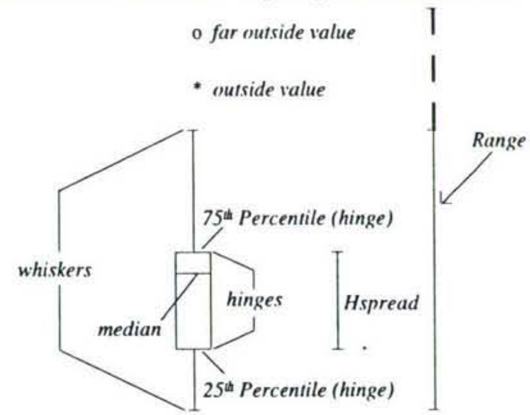
Plot of Sample-Specific Concentrations for Driving Soil COCs

Tooele

Prepared by: Ebasco Services Incorporated

Recycled Paper

Box plots provide a simple graphical summary of a data set, identifying the median and outside values in a batch. For this assessment, box plots are used to illustrate the distributions of sample-specific COC concentrations vis' a vis' corresponding corrective action levels (developed for current site uses), residential-use RBSLs, and site-specific background levels. The following diagram illustrates the information provided in the box plot.



The center line marks the ***median***, the value above (or below) which half the data (risk or HI) values fall.

The lower and upper ***hinges*** mark the lower and upper quartiles (25th and 75th percentiles) of the data, i.e., 25 percent of the values are at or below the bottom hinge value, and 25 percent of the values equal or exceed the upper hinge value.

The ***whiskers*** mark the minimum and maximum data values <u>except</u> the outliers (outside and far outside values) defined below.

* Marks the ***outside values***, the values outside the inner fences, which are defined as follows:

lower inner fence = lower hinge - 1.5 x Hspread
upper inner fence = upper hinge + 1.5 x Hspread

<u>*where:*</u> ***Hspread*** represents the interquartile range or mid-range, which is the absolute value of the difference between the value of the two hinges.

o Marks the ***far outside values***, the values outside the outer fences, defined as follows:

lower outer fence = lower hinge - 3.0 x Hspread
upper outer fence = upper hinge + 3.0 x Hspread

For additional information about box (schematic) plots, consult Morgan and Henrion (1990). Density plots showing individual sample detections are also provided in this figure to expand upon the information presented in the box plots.

Figure 5.1-2 **4 of 4**

Plot of Sample-Specific Concentrations for Driving Soil COCs

Tooele
Prepared by: Ebasco Services Incorporated

The ERA explored potential risk to biota at SWMUs 1 and 25 by addressing four questions:

1. Are contaminants present that have harmful characteristics in concentrations that could be harmful to biota?

2. What vegetation and wildlife species are present that could be harmed, if any?

3. Do pathways exist that expose biota to contaminants?

4. Is there a potential risk to biota from contamination and is this potential risk significant?

The methods used to conduct this screening-level ERA focus on developing and applying criteria to select receptors and contaminants, identifying exposure pathways for exposure, and researching the literature to determine the toxicity of the selected contaminants. The receptor and pathways anaiysis and the COC and toxicity analysis were then integrated to determine whether potential ecological risk is present and to suggest further analysis when significant concerns are apparent.

This process is documented in the following ERA components:

- Determination of potentially exposed biota involving a site-wide habitat characterization and selection of biota receptors for SWMUs 1 and 25

- Selection of COCs

- Performance of a qualitative exposure assessment

- Performance of a toxicity assessment

- Performance of a qualitative risk characterization

5.2.2 <u>Determination of Potentially Exposed Biota</u>

This section characterizes the TEAD-S biosphere by describing the site-wide vegetation and wildlife habitats, indicating potential biota receptors, and discussing the receptors' behavioral attributes that can lead to exposure.

The following sections include a characterization component and a comparison component. The characterization component describes TEAD-S site-wide habitats and indicates which specific habitats are contained within SWMUs 1 and 25. These habitats are the foundation on which the

community analysis and any subsequent qualitative ecological sampling recommendations are based.

5.2.2.1 Characterization of TEAD-S Habitats

The vegetation of TEAD-S is best described as a sagebrush community tending towards a desert shrub community on the valley floor. SWMU 1 is part of the sagebrush community, whereas SWMU 25 lies in a transition zone between sagebrush and desert shrub communities (Plate 3). The plant communities are typical of the region. The U.S. Forest Service describes the sagebrush physiographic region as extending into the central portion of the Great Basin, (i.e., Utah, Nevada, and southern Idaho) (Garrison et al. 1977). The desert shrub community occurs on the salt flats of the Great Salt Lake as well as the western third of the Great Basin.

The distribution of the sagebrush and desert shrub communities is influenced at TEAD-S by environmental gradients in geomorphology, soil salinity, and soil drainage. In general, geomorphology, salinity, and soil drainage change along a gradient from the northeastern corner of the installation to the southwestern corner. Well-drained soils distributed on alluvial material characterize the northeastern half of the installation and poorly drained soils distributed on the valley floor characterize the southwestern corner (see Section 2.1.3). Soil salinity changes from relatively low to high in a gradient from northeast to southwest across the installation. Vegetation communities and the species that inhabit them have responded through time to these environmental gradients.

Seventeen distinctive vegetation types were identified on TEAD-S (Table 5.2-1). The initial vegetation types were defined using SCS plant associations (SCS, no date), dominant structures (e.g., tree, shrub, grass, etc.) and dominant species (e.g., 60 percent of one species indicates a dominant shrub type). However, the map was created using aerial photographs and then verified in the field in a site-wide survey. Because actual vegetation types reflect responses to physical man-made disturbance, different successional stages and responses to different disturbance regimes are incorporated in the natural landscape.

Each of the vegetation types can be placed in one of six habitat types on the basis of its physiognomy or visual aspects. These habitat types are the following:

- Upland Shrub habitat
- Upland Grass habitat
- Salt Shrub habitat

Habitat/Vegetation Type	Dominant Species
Upland Shrub Habitat	
Big Sagebrush	*Artemesia tridentata*, with grass and forb understory
Big Sagebrush-Greasewood	*Artemesia tridentata* and *Sarcobatus vermiculatus*, with grass and forb understory
Big Sagebrush-Greasewood-Rabbitbrush	*Artemesia tridentata*, *Sarcobatus vermiculatus*, and *Chrysothamnus nauseosus*, with grass and forb understory
Upland Grass Habitat	
Bunchgrass, Annual Forbs	*Elymus cinereus*, *Sitanion hystrix*, *Halogeton glomeratus*
Annual Grass and Forbs	*Bromus tectorum*, *Halogeton glomeratus*, *Lepidium perfoliatum*, *Salsola iberica*
Salt Shrub Habitat	
Saltbush	*Atriplex confertifolia*, *Atriplex canescens*
Snakeweed, Saltbush, Grasses	*Guterrezia sarrothrae*, *Artemesia pygmeae*, *Atriplex confertifolia*, *Atriplex canescens*, *Atriplex gardneri*, with some bunchgrasses and forbs
Greasewood	*Sarcobatus vermiculatus* with little understory
Alkali Meadow Habitat	
Rabbitbrush, Alkali Grass, Juncus	*Chrysothamnus nauseosus*, with an understory of *Distichlis spicata*, *Juncus* sp.
Alkali Grass, Juncus, Foxtail Grass	*Distichlis spicata*, *Juncus* sp., *Hordeum jubatum*, and other alkaline tolerant species
Alkali Pan with Saltblite	*Allenofera occidentalis*
Ephemeral Marshland	*Juncus* sp. and other ephemeral wetland species

Habitat/Vegetation Type	Dominant Species
Riparian Habitat	
Riparian	*Tamarix pentandra* or *Ulmus pumila*
Human-Altered Habitats	
Agricultural Land	Alfalfa, wheat
Managed Grasslands	*Agropyron cristatum*
Reseeded Grasses with Tree Plantings	*Agropyron cristatum*, with *Ulmus pumila*, *Juniperus* sp.
Structures	Human-made structures
Disturbed Areas	*Halogeton glomeratus*, *Salsola iberica*, *Bromus tectorum*, bare ground

- Alkali Meadow habitat
- Riparian habitat
- Human-Altered habitat

The habitats are described in detail below. The riparian habitat is not found in SWMUs 1 and 25.

Upland Shrub Habitat

The upland shrub habitat is typically found in areas of well-drained soils and low salinity. These areas are relatively dry and generally dominated by sagebrush (*Artemisia* sp.) species that contribute at least one-quarter of the total species composition. Structural components consist of 1– to 6–ft shrubs with an understory of grass and forbs or large amounts of bare ground. Upland shrub habitats are used by a variety of wildlife including year-round residents, winter residents, or summer residents. Year-round residents include red-tailed hawks, great horned owls, and golden eagles. Winter residents include bald eagles, rough-legged hawks, and prairie falcons. Summer species include American kestrels and ferruginous hawks. During periods of migration (spring and fall) the number of these raptors increases due to the addition of a migrant population passing through Rush Valley. The raptors feed on black-tailed jackrabbits, small birds, reptiles, and small rodents, which in turn feed on insects and plants. Wildlife species that specifically characterize the upland shrub habitats are great horned owls, red-tailed hawks, loggerhead shrikes, badgers, Ord's kangaroo rats, horned larks, and sagebrush lizards. The vegetation types associated with the upland shrub habitat are the following:

- Big Sagebrush
- Big Sage, Greasewood, and Rabbitbrush
- Big Sage, and Greasewood

The structure of these vegetation types is similar, so the fauna present in each type is also similar.

Upland Grass Habitat

Like the upland shrub habitat, the upland grass habitat is found in areas of well-drained soils and low salinity, although it lacks the shrub components in its plant composition. Upland grass habitat may be a successional stage to upland shrub habitat that has been removed by past disturbances or may possess environmental components that enable the grasses to compete better

than the shrubs. These areas provide wildlife habitat for black-tailed jackrabbits, ground squirrels, and ground-dwelling birds. Vegetation types found in this habitat are the following:

- Bunchgrass and Annual Forbs
- Annual Grasses and Forbs

Salt Shrub Habitat

Salt shrub habitat exists where environmental gradients are in transition. Soil is more poorly drained than in upland areas and has increased salinity. However, soil salinity is not as high, nor soil drainage as low, as on the valley floor (see Section 2.1.3). These areas generally contain xeric shrubs, particularly saltbush (*Atriplex* sp.), which make up at least one-quarter of the total species composition. Structural components consist of 4-inch to 3-foot shrubs with an understory of grass and forbs or large amounts of bare ground. Generally, kangaroo rats and pocket mice are common, as are black-tailed jackrabbits and antelope ground squirrels (Garrison et al. 1977). The most commonly observed raptor was the northern harrier, although all raptors on TEAD-S may utilize any habitat at any time given their large home range.

Vegetation types associated with this habitat are the following:

- Saltbush
- Snakeweed, Saltbush, and Grasses
- Greasewood

Alkali Meadow Habitat

The alkali meadow habitat is typically found in areas of poorly drained soils and high salinity. This habitat is found on the valley floor in the southwestern corner of the installation, and may be found in areas that tend to remain flooded during the spring. The vegetation reflects to what degree the soil retains moisture and salinity: typical species are alkali grass and juncus. Normally, this habitat is devoid of shrubs and, therefore, has limited habitat structure. Depending on the frequency of flood events, shrubs such as rabbitbrush begin to invade, even though they are often destroyed during the next flood. Areas that are flooded most frequently support ephemeral marshlands where *juncus* dominates, or support alkali pans devoid of all vegetation except saltblite. As with the salt shrub habitat, the alkali meadow habitat is especially used by northern harriers because the low vegetation height facilitates this raptor's hunting strategy. American kestrels also utilize the meadow areas for hunting. Black-tailed jackrabbits, deer mice, meadow voles, and horned larks are typical residents of alkali meadows and serve as common

prey for raptors. During floods, waterfowl, shorebirds, amphibians, and macroinvertebrates frequent the ephemeral marshlands and alkali pan. Vegetation types associated with the alkali meadow habitat are the following:

- Rabbitbrush, Alkali Grass, and Juncus
- Alkali Grass, Juncus, and Foxtail Grass
- Alkali Pan with Saltblite
- Ephemeral Marshland

Riparian Habitat

Riparian habitat is limited at TEAD-S, and is partially or entirely influenced by human activities. It is found along the Ophir Creek drainage near the main entrance and the irrigation ditch that runs parallel to Harrison Road north of the igloo storage area (Plate 3). These areas include salt cedar trees (irrigation ditch), elms trees (along Ophir Creek), or tall shrubs. They offer cover for song birds, including cavity-nesting birds, and also serve as perching sites and possible nesting sites for raptors that might otherwise not be present on-post. The vegetation type identified for this habitat is listed as riparian.

Human-Altered Habitats

TEAD-S contains many areas that have been altered or maintained to serve many uses as part of Depot activities. This habitat is described by the following "vegetation" types:

- Agricultural Land
- Managed Grasslands
- Reseeded Grasses with Tree Plantings
- Structures
- Disturbed Areas

This habitat is intermixed among the native vegetation and is not dependent on environmental gradients. Managed areas are typically apparent as geometric shapes (Plate 3). All types, excluding disturbed areas, must be maintained to prevent vegetation from reverting to native types. When these types are no longer maintained, their vegetation is naturally replaced by xeric plants. This situation is occurring in the former base housing area, where transplanted and ornamental trees are currently being replaced by xerophillic plants.

The vegetation types in this habitat offer different habitat qualities and uses. Structures such as fences, buildings foundations, and telephone poles provide nesting cover, escape cover, and

resting areas for many birds and some rodents and reptiles. Agricultural lands may provide forage for herbivorous species and, if harvesting is timed after the breeding season, nesting cover for many ground-nesting birds. Managed grasslands are typically found in secured areas at TEAD-S, and they are usually mowed, which decreases the inhabitant value for ground-nesting birds and rodents. Conversely, structures found within the managed grasslands offer alternative nesting areas for birds and rodents in quiet areas where human activities are limited. Areas with reseeded grasses and trees were formerly managed as landscaped areas at the main entrance and the former housing areas. Trees provide beneficial additions to an ecosystem typically vegetated by shrub communities, adding special structural components to the habitat that provide nesting sites for wintering raptors and many small birds that may not otherwise be present.

The last vegetation type in the human-altered habitats is disturbed areas. These areas are either sparsely vegetated or are bare ground, and are typically associated with annual plants. Disturbances can be a result of chemical interactions or physical disruptions, so this type includes earthen mounds, pits, trenches, and bare areas. These areas attract wildlife because their disturbed soil provides good burrowing sites for small rodents and dusting areas for rabbits and small birds. Some areas may retain rain water for short periods and thereby provide water for birds and mammals. The prey in disturbed areas in turn attract raptors, badgers, and coyotes.

5.2.2.2 Habitat Types in SWMUs 1 and 25

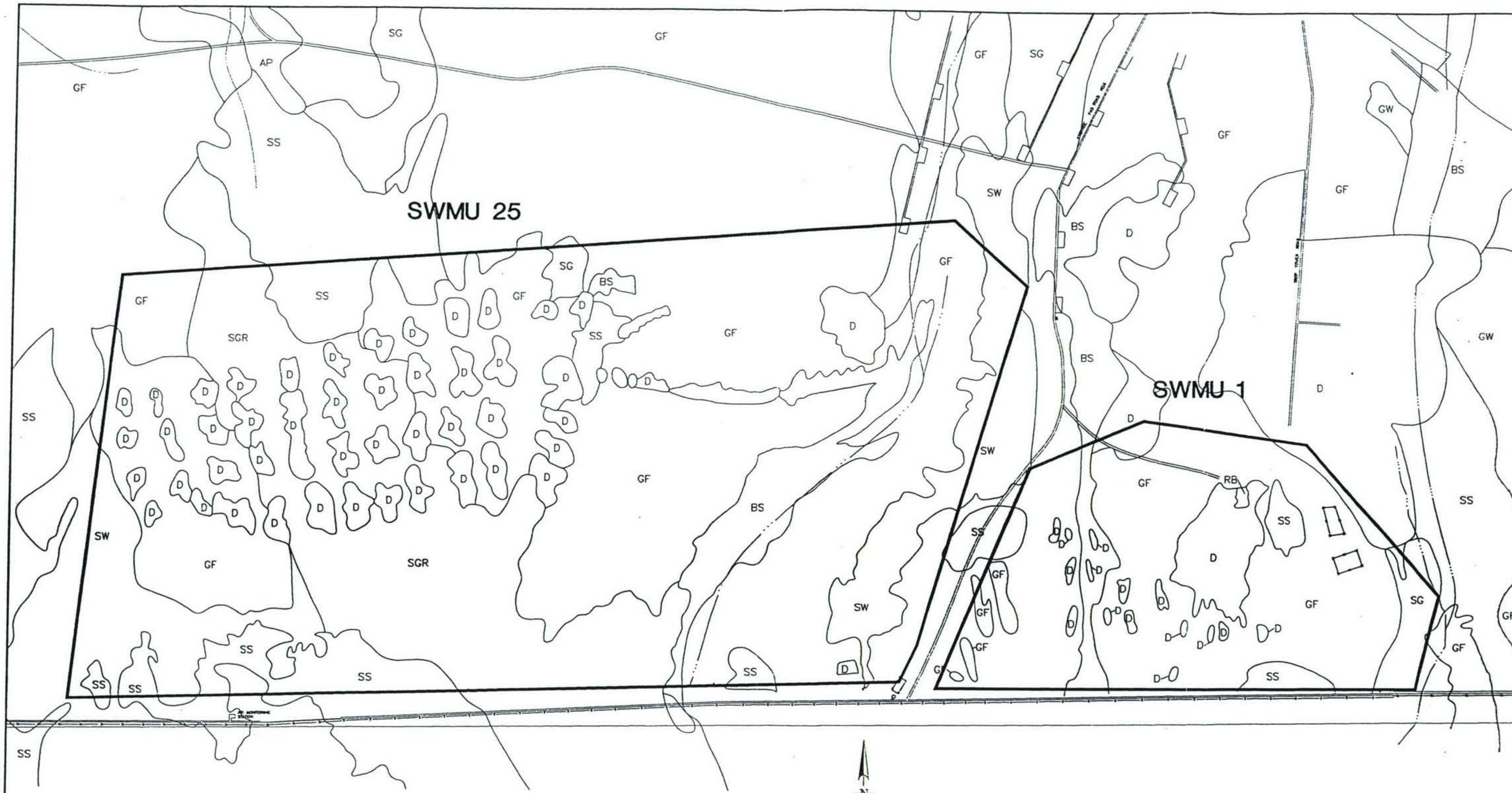
Table 5.2-2 lists the habitats and vegetation types identified in SWMUs 1 and 25 during ecological surveys. Approximately half (8 of 17) of the vegetation types found on TEAD-S occur in SWMUs 1 and 25. SWMU 1 is dominated by upland grass habitat, whereas SWMU 25 (Figure 5.2-1) contains upland grass, upland shrub, and salt shrub habitat. Both SWMUs 1 and 25 contain many disturbed areas (Plate 3).

The vegetation map of TEAD-S (Plate 3) was compared to other Tooele County studies to validate it and place it in context. These studies included in the following:

- U.S. Forest Service, Vegetation and Environmental Features of Forest and Range Ecosystems (Garrison et al. 1977).
- SCS, Soil and Range Survey of the Tooele Army Depot (no date). Supplemented by Tooele County soils maps and descriptions.

Table 5.2-2 Habitat and Vegetation Types of SWMUs 1, 25, and 37

Habitat Type	SWMU Where Identified
Upland Shrub Habitat	
Big Sagebrush	1, 25
Big Sagebrush-Greasewood	1, 25
Big Sagebrush-Greasewood-Rabbitbrush	25
Upland Grass Habitat	
Bunchgrass, Annual Forbs	1, 25, 37
Annual Grass and Forbs	37
Salt Shrub Habitat	
Saltbush	1, 25
Snakeweed, Saltbush, Grasses	25
Alkali Meadow Habitat	
Rabbitbrush, Alkali Grass, Juncus	1
Human Altered Habitats	
Disturbed Areas	1, 25, 37



EXPLANATION

SS = SALTBRUSH
SG = B.SAGE/GREASEWOOD
GW = GREASEWOOD
BS = BIG SAGE
WA = ALKALI GRASS, JUNCUS, FOXTAIL
RB = RABBIT BRUSH, ALKALI GRASS, JUNCUS
D = DISTURBED
AP = ALKALI PAN WITH SALTBITE
SGR = B.SAGE, GREASEWOOD, RABITBRUSH
GF = BUNCHGRASSES/ANNUAL FORBS
SW = SNAKEWEED, PIGMY SAGE, SALTBRUSH, GRASS
AGF = ANNUAL GRASSES AND FORBS

LEGEND

SWMU Fence Boundary
Facility Boundary
Major Access Roads
Surface Water Drainage

-N-

0 250 500 750 1000
SCALE IN METERS
0 1000 2000 3000
SCALE IN FEET

Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 5.2-1

SWMU 1 and 25 Vegetaion Map

Prepared by:
Ebasco Services Incorporated

- BLM, The Tooele Grazing Draft Environmental Impact Statement (EIS) (1983). The Pony Express Resource Management Plan and Draft Environmental Impact Statement (BLM 1988), was also to be used as a comparative document (EBASCO 1993b), but a draft version of the Tooele Grazing Environmental Impact Statement (BLM 1983) was determined to be more detailed and was used instead.

The information in these three documents adds regional and local perspective to the vegetation map of TEAD-S. The U.S. Forest Service (Garrison et al. 1977) gives descriptions of two ecosystems that characterize the overall sagebrush and desert shrub vegetation at TEAD-S. However, the description of the sagebrush ecosystem best characterizes TEAD-S and also best fits the geographic description of this ecosystem. Further, sagebrush is the predominant vegetation in the upland habitats at TEAD-S.

SCS (no date) plant associations were used as a basis for vegetation mapping. However, the final TEAD-S vegetation map (Plate 3) differs from the SCS plant associations for two reasons. First, SCS maps soil types and the potential vegetation that the soil types will support, whereas actual vegetation mapped during the RFI-Phase II at TEAD-S reflects man-made disturbances and natural disturbance regimes that create various successional stages of the potential climax vegetation. Second, SCS vegetation associations are oriented toward range-management requirements, whereas the TEAD-S map was oriented to broad ecological requirements. Rangeland needs focus on forage production and livestock nutrition, whereas ecological requirements reflect food, cover, and reproductive requirements for each wildlife habitat. For these two reasons, the two maps are not directly comparable.

Finally, the habitat types found at TEAD-S were compared to the vegetation types found in the Tooele Grazing Draft EIS (BLM 1983). Table 5.2-3 lists BLM vegetation types in proximity to TEAD-S habitats. Overall, the lists are quite similar, except when TEAD-S alkali meadow and riparian habitats are compared to BLM barren and riparian areas. The species are similar but are grouped differently. This difference is primarily the result of scale at which the vegetation types were mapped: the area covered in the Tooele Draft Grazing EIS covers over 1 million acres, and the TEAD-S vegetation map covers a 19,355-acre area. This difference in area has a profound effect on how vegetation is viewed and mapped. Since smaller areas were mapped for TEAD-S, identification of many more vegetation types was possible. For example, the Tooele Grazing Draft EIS recognizes only one large type of upland shrub habitat, sagebrush. Furthermore, the BLM vegetation scheme does not identify wetland areas as being separate from riparian areas, which explains the difference between alkali meadow habitat in the TEAD-S map and

Table 5.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Upland Shrub	Big Sagebrush	Sagebrush	Big Sagebrush	*Artemisia tridentata*
			Black Sagebrush	*Artemisia nova*
	Big Sagebrush, Greasewood		Big Rabbitbrush	*Chrysothamnus nauseosus*
			Little Rabbitbrush	*Chrysothamnus viscidiflorus*
	Big Sagebrush, Greasewood, Rabbitbrush		Bitterbrush	*Purshia tridentata*
			Bluebunch Wheatgrass	*Agropyron spicatum*
			Crested Wheatgrass	*Agropyron cristatum*
			Cheatgrass	*Bromus tectorum*
			Sandberg Bluegrass	*Poa secunda*
Upland Grass	Bunchgrass, Annual Forbs	Perennial Grass	Bluebunch Wheatgrass	*Agropyron spicatum*
			Indian Ricegrass	*Oryzopsis hymenoides*
			Crested Wheatgrass	*Agropyron cristatum*
			Squirreltail	*Sitanion hystrix*
			Needle and Thread	*Stipa comata*
			Salina Wildrye	*Elymus salina*
	Annual Grass and Forbs	Annuals	Cheatgrass	*Bromus tectorum*
			Halogeton	*Halogeton glomeratus*
			Peppergrass	*Lepidium perfoliatum*
			Russian Thistle	*Salsola kali*

Table 5.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Salt Shrub	Saltbush	Desert Shrub/Saltbush	Shadscale	*Atriplex confertifolia*
			Nuttall's Saltbush	*Atriplex nuttallii*
	Snakewood, Saltbush, Grasses		Little Rabbitbrush	*Chrysothamnus viscidiflorus*
			Mormon Tea	*Ephedra nevadensis*
			Winterfat	*Ceratoides lanata*
			Indian Ricegrass	*Oryzopsis hymenoides*
			Squirreltail	*Sitanion hystrix*
			Cheatgrass	*Bromus tectorum*
			Spineless Horsebrush	*Tetradymia spp.*
			Halogeton	*Halogeton glomeratus*
	Greasewood	Greasewood	Greasewood	*Sarcobatus vermiculatus*
			Bud Sagebrush	*Artemisia spinescens*
			Shadscale	*Atriplex confertifolia*
			Saltgrass	*Distichlis stricta*
			Halogeton	*Halogeton glomeratus*
			Gray Molly	*Kochia americana*
			Russian Thistle	*Salsola kali*
			Alkali Sacaton	*Sporobolus airoides*

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Table 5.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Alkali Meadow	Alkali Pan with Saltblite	Barren	Pickleweed	*Allenrolfea occidentalis*
			Saltgrass	*Distichlis stricta*
			Alkali Sacaton	*Sporobolus airoides*
	Rabbitbrush, Alkali Grass, Juncus	Riparian Habitat	Bentgrass	*Agrostis spp.*
	Alkaligrass, Juncus, Foxtail Grass		Brome Grass	*Bromus spp.*
	Ephemeral Marshland		Sedge	*Carex spp.*
			Rush	*Juncus spp.*
			Muhly Grass	*Muhlenbergia spp.*
Riparian	Riparian Areas (Salt Cedar/Elm Trees)		Bluegrass	*Poa spp.*
			Yarrow	*Achillea millefolium*
			Aster	*Aster spp.*
			Indian Paintbrush	*Castilleja spp.*
			Penstemon	*Penstemon spp.*
Human-Altered	Agricultural Land	Cropland		
	Managed Grassland			
	Reseeded Grasses with Tree Planting			
	Structures			
	Disturbed Areas			

* Taken from Tooele Grazing EIS (BLM 1983)

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barren/riparian types listed by BLM. Such a difference can also be related to the BLM focus on range management needs. For example, BLM designates wetlands as a range/vegetation type, even though livestock are unlikely to use these areas.

Overall, the TEAD-S vegetation map is comparable to the other mapping schemes used in the Rush Valley area. It is a good representation of actual vegetation at TEAD-S and can serve as a basis for future land-use management and ecological assessment.

5.2.2.3 Site–Wide Wildlife Concerns

TEAD-S harbors a large and diverse winter raptor community. These raptors, including the endangered bald eagle, have migrated from northern regions of the U.S. and Canada to find appropriate habitat (e.g., trees, prey, solitude) at TEAD-S to establish winter roosts. TEAD-S also provides appropriate nesting habitat during the summer for species including golden eagles, red-tailed hawks, ferruginous hawks, American kestrels, and great horned owls.

Federal threatened and endangered listings include the bald eagle and the peregrine falcon. Roosting bald eagles have been observed during winter ecological surveys along Mercur Creek and in the elm tree directly between SWMUs 1 and 25. No peregrine falcons have been observed at TEAD-S. Although unaltered hunting habitat and a prey base at TEAD-S are within 16 kilometers of potential nesting habitat in the Oquirrh Mountains to the east, no peregrine nesting sites are known within this radius (Howe, 1992).

The State of Utah threatened species list includes the ferruginous hawk. This species has been observed on-post during ecological surveys and is a confirmed summer resident and breeding bird in Rush Valley. The ferruginous hawk is highly sensitive to human development. Table 5.2-4 lists all species of concern and their federal and state regulatory status.

Other species of concern as listed by the State of Utah include the loggerhead shrike, the black tern, the snowy plover, the long-billed curlew, and the Swainson's hawk. These species are of concern due to declining populations or loss of habitat.

Table 5.2-4 Federal and State of Utah Status for TEAD-S Species of Concern

Common Name	Species Name	Federal Status*	State Status**
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered
Peregrine falcon	*Falco peregrinus*	Endangered	Endangered
Ferruginous hawk	*Buteo regalis*	Category 2	Threatened
Loggerhead shrike	*Lanius ludovicianus*	Category 2	Declining population
Black tern	*Chlidonias niger*	Category 2	Declining population
Snowy plover	*Charadrius alexandrinus*	Category 2	Declining population, limited distribution
Long-billed curlew	*Numenius americanus*	Category 2	Declining population, limited distribution
Swainson's hawk	*Buteo swainsoni*	Category 3C	Declining population, limited distribution

* Category 2 status indicates more research is needed to list this species as threatened or endangered. A Category 3C status indicates more research is desired before delisting or inclusion with Category 2.

** From the current draft form of Native Utah Wildlife Species of Special Concern (UDOW 1993).

5.2.2.4 Potential Biota Receptors

This section describes how potential biota receptors for which qualitative risk will be assessed were selected from plant and wildlife species identified in the SWMUs or in similar habitats elsewhere on TEAD-S (see Appendix H). The appropriate and representative species were selected as potential receptors using standardized criteria.

Vegetation and wildlife can be exposed to contaminants through behavioral attributes such as birds taking dust baths, rodents burrowing through the soil, or hawks consuming rabbits. If contamination is present, behavioral attributes may cause wildlife species to ingest, or to a lesser extent inhale or absorb, contaminants that may then be assimilated into their tissues. This is also true for plants that may take in contaminants directly from soil or surface water. If enough of a contaminant is assimilated, that result in toxic effects may occur in biota. Toxic effects can include stressed or dying vegetation, abnormal behavior, reduced productivity, or increased mortality.

With these general considerations in mind, six standardized selection criteria were used to select the following kinds of biota receptors:

- Game species of commercial or economic importance
- Major prey for species of concern
- Species representative of certain food chains or key trophic levels (e.g., primary producers that provide a food chain foundation)
- Species of local interest to the public (e.g., the pronghorn antelope recently reintroduced into Rush Valley; see BLM 1988)
- Species that have a population sufficiently large at TEAD-S to support any future bioassay testing or monitoring.
- Species or taxonomic groups for which toxicity data are available in the scientific literature

Table 5.2-5 lists these criteria along with common names of selected species, their taxonomic groups, and trophic groups. The receptors were selected if at least three of the criteria were met. Sixteen species were selected from the more common ones observed in SWMUs 1 and 25 (see Appendix H). In addition the badger as selected because it is the only mammalian predator at TEAD-S, has a different metabolic rate than an avian predator, and preys exclusively on rodents that burrow in the soil. The biota receptors selected are representative of the species, including the species of concern (Table 5.2-4), that would be likely to be exposed to COCs in SWMUs 1 and 25. The selected biota receptors are not representative of the black tern, snowy plover or long-billed curlew, because these species of concern are typically associated with water and are unlikely to be present in the Group 1 SWMUs.

The 16 receptors were combined into five generalized trophic (feeding) groups: plants, small birds, small mammals, predatory birds, and predatory mammals. These trophic groups will be used to relate exposure routes and to characterize risk.

5.2.3 Selection of Ecological Chemicals of Concern

Approximately 150 elements, compounds, and anions were analyzed during soil and water sampling at SWMUs 1 and 25. Chemicals of concern to biota (biota COCs) were selected from analytes detected in soil because groundwater is not considered a pathway to biota (see Section 5.2.4.2), there is no perennial surface water in or near SWMUs 1 or 25, and ephemeral surface water has not been apparent since the craters in these SWMUs were filled. The biota COCs are those analytes that are detected in sufficient quantities and in sufficiently large areas to pose a potential ecological risk.

COCs were chosen using three exposure criteria and two toxicological criteria. The three exposure criteria are calculations with arbitrary decision points that assess whether significant exposure to the contaminant could occur. The toxicological criteria help determine whether exposure to the analyte is potentially hazardous to ecological receptors. Table 5.2-6 provides descriptive statistics for the analytes detected in soil at SWMUs 1 and 25. The following describes how the criteria are used to select COCs:

- Detection Frequency—The number of detections divided by the number of samples must be ≥ 0.05.

Table 5.2-5 Selection of Representative Biota Receptors for SWMUs 1 and 25

Common Name	Taxonomic Group	Trophic Group	Game Species	Major Prey for Species of Concern	Important Representative of Food Chain	Local Interest	Population Sufficiently Large on TEAD-S	Literature Data Available on Toxicity	Selected Species
Big Sagebrush	Shrub	Primary Producer			X		X	X	X
Saltbush	Shrub	Primary Producer			X		X	X	X
Indian Ricegrass	Grass	Primary Producer			X		X	X	X
Crested Wheatgrass	Grass	Primary Producer			X		X	X	X
Pronghorn Antelope	Mammal	Herbivore	X			X		X	X
Mule Deer	Mammal	Herbivore	X					X	
Black-Tailed Jackrabbit	Mammal	Herbivore	X	X	X		X	X	X
Herbivores Ground Beetle/ Grasshoppers	Insect	Herbivore		X	X		X		X
Vesper Sparrow	Bird	Herbivore			X		X	X	X
Horned Lark	Bird	Omnivore			X		X	X	X
Sagebrush Lizard	Reptile	Omnivore		X	X				
Kangaroo Rat	Mammal	Omnivore		X	X		X	X	X
Deer Mouse	Mammal	Omnivore		X	X		X	X	X
Western Meadowlark	Bird	Omnivore			X		X	X	X

Table 5.2-5 Selection of Representative Biota Receptors for SWMUs 1 and 25

Common Name	Taxonomic Group	Trophic Group	Game Species	Major Prey for Species of Concern	Important Representative of Food Chain	Local Interest	Population Sufficiently Large on TEAD-S	Literature Data Available on Toxicity	Selected Species
Predatory Ground Beetle	Insect	Predator			X				
Great Basin Gopher Snake	Reptile	Predator			X				
Loggerhead Shrike	Bird	Predator			X	X	X		X
Northern Harrier	Bird	Predator			X		X	X	X
American Kestrel	Bird	Predator			X			X	
Badger	Mammal	Predator			X			X	X
Red-Tailed Hawk	Bird	Predator			X		X	X	X

Table 5.2-6 Initial Screening of Surficial Soil Analytes for SWMUs 1 and 25 Using Exposure Criteria

Detected Chemical	Media	Certified Reporting Limit (CRL) (µg/g)	Arithmetic Mean of Samples[1] (µg/g)	Arithmetic Mean of Detections (µg/g)	Max Values (µg/g)	Detection Frequency[2]	Spatial Distribution[3]	Magnitude Ratio based on: Total Samples[4]	Max Hit
Semivolatile Organics									
bis(2-ethylhexyl) phthalate (B2EHP)	Soil	4.80E-01	7.02E-01	3.60E+00	8.40E+00	0.136	W	1.46E+00	1.75E+01
Metals and Cyanide									
Aluminum (Al)	Soil	1.12E+01	2.38E+04	2.38E+04	1.70E+05	1.00	W	1.34E+00	9.60E+00
Arsenic (As)	Soil	2.50E+00	1.21E+01	1.21E+01	7.70E+01	1.00	W	4.44E-01	2.82E+00
Barium (Ba)	Soil	3.60E-01	2.22E+03	2.25E+03	2.10E+04	0.985	W	4.13E+00	3.92E+01
Beryllium (Be)	Soil	4.27E-01	5.81E-01	7.68E-01	1.28E+00	0.612	W	6.51E-01	1.43E+00
Cadmium (Cd)	Soil	1.20E+00	5.94E+00	1.28E+01	1.41E+02	0.433	W	6.05E+00	1.44E+02
Calcium (Ca)	Soil	2.53E+01	1.24E+05	1.24E+05	4.80E+05	1.000	W	8.48E-01	3.29E+00
Chromium (Cr)	Soil	3.60E-01	1.87E+02	1.87E+02	5.30E+03	1.000	W	7.47E+00	2.11E+02
Cobalt (Co)	Soil	2.50E+00	7.40E+00	7.61E+00	5.20E+01	0.955	W	1.12E+00	7.87E+00
Copper (Cu)	Soil	2.84E+00	3.63E+02	3.69E+02	6.70E+03	0.985	W	1.45E+01	2.67E+02
Cyanide (CYN)	Soil	2.50E-01	1.02E+00	3.39E+00	1.80E+01	0.273	W	4.07E+00	7.20E+01
Iron (Fe)	Soil	6.66E+00	3.58E+04	3.58E+04	3.20E+05	1.000	W	2.04E+00	1.83E+01
Lead (Pb)	Soil	4.67E-01	9.33E+01	9.33E+01	1.10E+03	1.000	W	2.68E+00	3.16E+01
Magnesium (Mg)	Soil	1.01E+01	3.66E+04	3.66E+04	2.30E+05	1.000	W	2.26E+00	1.42E+01
Manganese (Mn)	Soil	9.87E+00	5.30E+02	5.30E+02	2.30E+03	1.000	W	8.06E-01	3.50E+00
Mercury (Hg)	Soil	5.00E-02	4.03E-02	1.21E-01	3.05E-01	0.152	W	4.80E-01	3.63E+00
Nickel (Ni)	Soil	2.74E+00	3.22E+01	3.26E+01	4.56E+02	0.985	W	1.65E+00	2.34E+01
Potassium (K)	Soil	1.31E+02	6.77E+03	6.87E+03	2.03E+04	0.985	W	8.53E-01	2.56E+00

1 Mean of all samples including a one-half CRL value for all values below the CRL.
2 Chemical must have a detection frequency of 0.05 to be considered as a COC.
3 Determined as widespread (W) or isolated (I) by the number of source areas with detections and the ratio of hits to samples by source area. Note that all of the chemicals were categorized as widespread.
4 Calculated as the ratio of sample means to background for metals or to CRL for other analytes.
Mg/g Micrograms per grams
NOTE: Chemicals that are in bold type have been designated as potential COCs.
NOTE: The scientific notation used in this table (e.g., E+05, E-02) identifies the number of spaces the decimal point should be moved to the right (when E is followed by a "+") or to the left (when E is followed by a "-"). For example, 1.24E+5 equals 124,000 and 4.03E-2 equals 0.0403.

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Table 5.2-6 Initial Screening of Surficial Soil Analytes for SWMUs 1 and 25 Using Exposure Criteria

Detected Chemical	Media	Certified Reporting Limit (CRL) (µg/g)	Arithmetic Mean of Samples[1] (µg/g)	Arithmetic Mean of Detections (µg/g)	Max Values (µg/g)	Detection Frequency[2]	Spatial Distribution[3]	Magnitude Ratio based on: Total Samples[4]	Max Hit
Silver (Ag)	Soil	8.03E-01	1.38E+00	4.47E+00	1.32E+01	0.239	W	3.16E+00	3.02E+01
Sodium (Na)	Soil	3.87E+01	1.01E+03	1.05E+03	1.15E+04	0.955	W	6.55E-01	7.47E+00
Thallium (Tl)	Soil	3.43E+01	2.30E+01	5.15E+01	8.50E+01	0.090	W	4.61E-01	1.70E+00
Vanadium (V)	Soil	1.41E+00	2.33E+01	2.39E+01	4.11+01	0.970	W	1.01E+00	1.78E+00
Zinc (Zn)	Soil	2.34E+00	6.52E+02	6.52E+02	2.40E+04	1.000	W	6.27E+00	2.31E+02

[1] Mean of all samples including a one-half CRL value for all values below the CRL.
[2] Chemical must have a detection frequency of 0.05 to be considered as a COC.
[3] Determined as widespread (W) or isolated (I) by the number of source areas with detections and the ratio of hits to samples by source area. Note that all of the chemicals were categorized as widespread.
[4] Calculated as the ratio of sample means to background for metals or to CRL for other analytes.
Mg/g Micrograms per grams
NOTE: Chemicals that are in bold type have been designated as potential COCs.
NOTE: The scientific notation used in this table (e.g., E+05, E-02) identifies the number of spaces the decimal point should be moved to the right (when E is followed by a "+") or to the left (when E is followed by a "-"). For example, 1.24E+5 equals 124,000 and 4.03E-2 equals 0.0403.

- Spatial Distribution—To meet the spatial distribution criterion and be designated as widespread, the chemical must be detected in at least three of the eight source areas in SWMUs 1 and 25 or professional judgment may be used to include it based on a high detection frequency within fewer source areas. Chemicals not meeting this criterion are designated as isolated.

- Magnitude—To meet the magnitude criterion, each of two subcriteria must both be met: (1) the ratio of the arithmetic mean of all samples to the background (or CRL) value must be greater than 1.0; and (2) the ratio of the maximum detection to the background (or CRL) value must be greater than 10.0. However, if the ratio of the arithmetic mean of all samples to background (or CRL) is between 0.75 and 1.0 and the ratio of the upper 95% confidence limit of all samples to background (or CRL) is greater than 1.0 then the first subcriterion will also be met.

Each of these three criteria must be satisfied before an analyte is selected as a potential COC.

As shown in Table 5.2-6, bis(2-ethylhexyl)phthalate, aluminum, barium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, magnesium, mercury, nickel, silver, vanadium, and zinc meet all the exposure criteria and were designated as potential COCs. Several other metals selected using the exposure criteria failed to meet the toxicological criteria, as discussed below.

The toxicological criteria are persistence and toxicological endpoint effects:

- Persistence— The chemical must reside in surficial soil for a considerable duration to cause repeated exposure.

- Toxicological Endpoint Effects— The analyte is noted for acute and/or chronic effects, sublethal effects, or bioaccumulation (see Section 5.2.7).

The following analytes meet both the exposure and toxicological criteria and have not been designated as nutrients: cadmium, chromium, cyanide, lead, mercury, nickel, silver, vanadium, and zinc (Table 5.2-7). Other analytes that met both sets of criteria but do not pose environmental hazards because they are common in the natural environment and serve as nutrients are aluminum, calcium, copper, iron, magnesium, manganese, potassium and sodium. Calcium, potassium, and magnesium are plant macronutrients and iron and zinc are plant micronutrients; they are, therefore, essential to plant growth and nutrition and are noncritical in an assessment of toxic elements in the environment (Peterle 1991). Copper and manganese are also plant micronutrients. Sodium is essential to animal nutrition and extremely common to the soils in TEAD-S. Therefore, these analytes are not selected as COCs.

Table 5.2-7 Final Screening of Potential Surficial Soil COCs for SWMUs 1 and 25 Using Toxicological Criteria

Detected Chemical	Persistence	Toxicological Endpoints[1]	Bioaccumulation[2]
Aluminum (Al)[4]	X	X	
Cadmium (Cd)	X	X	X
Chromium (Cr)	X	X	X (in plants)
Cobalt (Co)	X		
Copper (Cu)[5]	X	X	X
Iron (Fe)[6]	X	X	
Lead (Pb)	X	X	
Magnesium (Mg)	X	X	
Mercury (Hg)[7]	X	X	X
Nickel (Ni)	X	X	X (in plants)
Silver (Ag)[3]	X	X	
Vanadium (V)	X	X	
Zinc (Zn)	X	X	X
Cyanide (CYN)	X	X	

1 Lethal or sublethal effects have been noted in the scientific literature for this analyte.
2 Bioaccumulation either in plants or animals has been noted in the scientific literature for this analyte.
3 Can be toxic to plants.
4 Noncritical element in the environment.
5 Values are below toxic levels for ruminants and rodents (Osweiler et al. 1973).
6 Noncritical element in the environment plus plant macronutrient.
7 Added as COC due to biomagnification abilities and high potential toxicity to biota.

Note: Chemicals that are in bold type have been designated as final COCs since they meet all three of the exposure criteria, both the toxicological criteria, and have not been designated as nutrients.

5.2.4 Exposure Assessment

The exposure assessment documents exposure of biota receptors that co-occur with environmental contaminants in two steps. First, potential pathways are considered in a conceptual model that demonstrates the mechanisms of potential exposure at the site. Second, exposure is documented through identification of pathways by which the receptors are exposed to the COCs.

A complete exposure pathway consists of four components: a source of potential contamination, a contaminant-release mechanism, a transport medium or secondary source, and a receptor. All components must be present and functional for exposure to occur. The sources at SWMUs 1 and 25 are those described in Section 4.2.2. The current release mechanisms at SWMUs 1 and 25 include storm-water runoff and percolation and leaching of water through contaminated soil. At one time, dispersion of contamination in soil may have occurred through explosion or combustion. Currently, contamination is no longer being released in this manner at the SWMUs.

At SWMUs 1 and 25, transport media are surface water and soil, which are also secondary sources of potential contamination. These media carry and disperse contaminants from the source areas and disperse contaminants across environmental media. For example, storm-water runoff can carry potentially contaminated soil from source areas. The contaminant may stay in the soil and be re-deposited away from the source area or, depending on its physical and chemical characteristics, go into solution in the surface water (secondary source). This water may then pond, where it is available for ingestion by animals or uptake through plant roots.

5.2.4.1 Conceptual Site Model

Consideration of a conceptual site model is a part of the problem-formulation portion of the ERA (EPA 1989d). The conceptual model is used to identify pathways that may be present at TEAD-S. Only those complete pathways most likely to contribute to risk at TEAD-S were selected for further evaluation. Figure 5.2-2, which illustrates the conceptual model for SWMUs 1 and 25, shows potential pathways for contaminant migration to biota receptors through the secondary sources of soil and surface water.

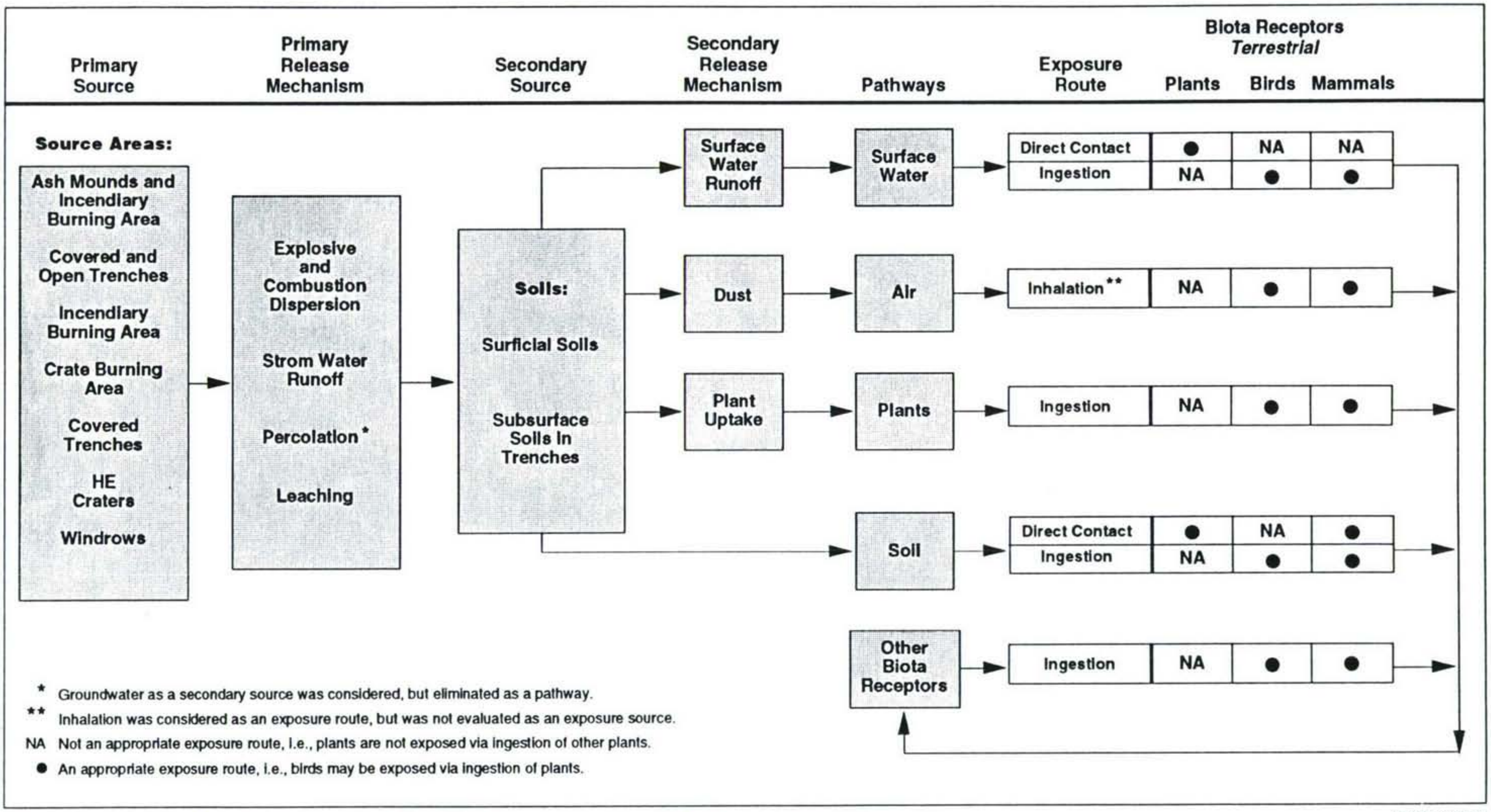

Figure 5.2-2 • TEAD-S Conceptual Model for Biota Receptors at SWMUs 1 and 25

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5.2.4.2 Documentation of Exposure

Exposure at SWMUs 1 and 25 was documented for groundwater, surface–water, and soil pathways (Figure 5.2-2). Although groundwater could be a secondary source of contamination, there is no potential for direct exposure of biota to groundwater. No groundwater seeps or wetlands that result from a resurfacing of groundwater were discovered in the SWMUs. Additionally, the potentiometric mapping of groundwater revealed no groundwater flow from SWMUs 1 and 25 to wetland areas to the northwest. Second, groundwater uptake from deeply rooted plants is unlikely, as the shallowest groundwater occurs at a depth of 15 feet in SWMU 25 (see Section 2.1.5), and the plant species with the deepest roots (shrubs) probably reach only to a depth of 6 to 9 ft. For example, studies show the maximum root depth of big sagebrush in Wyoming is between 6 and 7 ft (Sturges 1977) and of four-wing saltbush in New Mexico is between 8 and 9 ft (Stutz and Buchanan 1987).

Surface water is a secondary source, especially during spring snow melt. It is a potential pathway to biota receptors through plant uptake and direct animal ingestion by some birds. However, this source of surface water is extremely transitory. Further, Mercur Creek has been diverted around TEAD-S, Ophir Creek flows only occasionally in the northeast corner of TEAD-S, and Faust Creek is intermittent. The water occasionally ponded from Faust Creek is a potential exposure pathway to biota at TEAD-S, but not at SWMUs 1 and 25. Most mammals (except coyotes) and many birds (especially those animals selected as receptors) have adapted to the arid environment of TEAD-S by obtaining sufficient water directly from their food.

Soil is also a secondary source of potential contamination (Figure 5.2-2). There are four potentially complete pathways through soil to biota receptors. The first three pathways are associated with food web bioaccumulation through plant uptake and animal ingestion. First, contamination is taken up by plant roots, especially during periods of relatively high soil moisture (eg. spring runoff) and during periods of rapid plant growth in the spring. Second, contamination is incorporated into terrestrial food chains, such as ingestion of terrestrial plants by herbivores that are in turn ingested by higher consumers (predators). This pathway is particularly significant if bioaccumulative contaminants are present in soil. Third, contaminated soil can be directly ingested. Both birds and mammals may ingest soil daily (Beyer et al. 1991; Arthur and Gates 1988), accumulating contaminants in their tissues and introducing them into the terrestrial food chain. In fact, all potential pathways, whether through surface water or soil, are linked through the terrestrial food chains at SWMUs 1 and 25. This link is illustrated in the conceptual site model (Figure 5.2-2) by feedback loops to the "ingestion by predators" pathways box. The fourth

pathway, inhalation of COCs on particulates or as vapors, was not evaluated. Exposure through inhalation is considered minor relative to food web bioaccumulation.

5.2.5 Toxicity Assessment

To evaluate the toxicity of the nine COCs, toxicological profiles were compiled from the literature, including synoptic publications such as Biological Reports of Chemical Hazard Reviews by Ronald Eisler, Radioecology (Whicker and Schultz 1982) and the World Health Organization Publications from the International Program on Chemical Safety. This toxicological information is summarized below for metal and nonmetal COCs. Each discussion identifies the general mode of action or effect of the chemical and the literature source of the critical exposure concentrations. Appendix H provides further detail on the potential toxic effects of COCs on terrestrial plants and animals.

The critical exposure concentrations reflect either the lowest observed an adverse effect level (LOAEL), or the highest concentration at which no effect was observed (NOAEL), depending on the available literature (Table 5.2-8). LOAELs were used whenever they were available; NOAELs were used when they were available and LOAELs were not. When only a lethal dose was available in the literature, the value used was one order of magnitude lower than the lethal dose (i.e., the LD50, the lethal dose to 50 percent or more of the subject population, was used with a protection factor of 10). Note that the terms LOAEL or NOAEL are used loosely: the published studies did not always investigate a tightly controlled range of concentrations above and below the reported value. For this reason, the LOAELs were used in preference to NOAELs. For example, reported NOAELs that are not bounded by a slightly higher value that was shown to cause an effect could be much lower than the actual NOAEL.

For plants, critical exposure concentrations are typically expressed in the literature as the concentrations found in the soil to which the plant is exposed. For animals, these concentrations are typically expressed as the concentrations to which the animal is exposed by ingestion. Ingested concentrations are provided as doses (intake of the contaminant normalized to a daily rate per gram of body weight) or as dietary intake, which must be normalized.

Table 5.2-8 also provides factors for animals (dietary fraction and feed rate) that allow the conversion of the concentration in the animal's dietary component of soil to a daily dose per gram of its body weight. These conversion factors are specific to the species of test organism used to derive the critical exposure concentrations. Dietary feed rate and fraction were taken

Table 5.2-8 Critical Exposure Concentrations and Conversion Factors to Calculate Actual Exposure and Toxicity Reference Values

	Critical Exposure Concentrations				Conversion Factors	
	Plants		Animals			
COC	LOEC (μg/g)	EC50(μg/g)	LOAEL (μg/g in diet)*	LD50 (μg/g in diet)	FR (g/day)	DF
Cadmium	15.1 for vegetables	33-171 for vegetables	2 for rodents	3,000 for rodents*	15 for rats	0.063 for jack rabbits
Chromium	2.4 for vegetables	1.8-7.4 for vegetables	10 for ducklings	NA	61 for ducks	0.082 for ducks
Lead	200 for plants	NA	12 for dogs*	NA	143 for foxes	0.063 for jack rabbits
Mercury	2 for plants (cucumbers)	NA	0.5 for ducks	NA	61 for ducks	0.082 for ducks
Nickel	1.4 for natural vegetables	50 for plants	26 for rats*	260 for rats*	15 for rats	0.063 for jack rabbits
Silver	NA	NA	1,300 for rats*	6,000 for guinea pigs*	15 for rats	0.063 for jack rabbits
Vanadium	NA	NA	56 for rats*	NA	15 for rats	0.063 for jack rabbits
Zinc	400 for blue grass	2,000 for blue grass	317 for mice*	2,900 for mice*	3 for mice	0.02 for mice
Cyanide	NA	NA	600 for rats*	164 for coyotes*	15 for rats	0.063 for jack rabbits

* reported as a dose value in the literature, but converted to a portion in diet.

μg/g Micrograms per gram
ppm Parts per million
g/day Grams per day
LOEC Lowest Observable Effects Concentration, NOEC were used when LOEC were not available
EC50 Effect Concentration where the test plants weigh 50% less than control plants
LOAEL Lowest Observable Adverse Effects Level, NOAEL were used when LOAELs were not available
LD50 Lethal Dose to 50% of the test population
FR Feeding Rate per Day
DF Dietary Fraction
NA Not Available

from Gates (1988), Matsumura (1985), and Beyer et al. (1991). For plants, the critical exposure concentrations can be used without conversion. Site-specific daily dose (animals) or critical exposure concentrations (plants) can then be compared to a reference dose (animals) or critical exposure concentration (plants) to characterize ecological risk. The characterization of ecological risk is discussed in Section 5.2.6.

5.2.5.1 Toxicity of Metal COCs

There are eight metal COCs: cadmium, chromium, lead, mercury, nickel, silver, vanadium, and zinc. Their general site or mode of action and the basis of their critical exposure concentrations are discussed below. Their critical exposure concentrations and conversion factors are provided in Table 5.2-8.

Cadmium

Cadmium is toxic to plants and causes a reduction in growth and yield. Its effect and accumulation are affected by the concentrations of other trace elements. In animals, cadmium tends to accumulate in kidney and liver tissues where it may be complexed with a protein (metallothionein) and rendered less toxic (Klaassen et al. 1986). Cadmium can also cause sublethal effects such as cardiovascular disease, reduced growth rate, and behavioral impacts; high doses can be lethal. Cadmium tends to accumulate with age and in higher food-web trophic levels; it is eliminated by the kidneys with a half-life of about 100 days. Table 5.2-8 provides the critical exposure concentrations of cadmium. Critical exposure concentrations for plants were based on a mean of NOAEL soil concentrations for vegetables (Adema and Henzen 1989). For animals, a LOAEL diet value (Siewicki et al. 1983) for rats was used (see Appendix H).

Chromium

Chromium, in low concentrations and in the presence of other micronutrients, may serve as a plant growth stimulant. At higher concentrations, it may affect sodium and potassium balance and cause weight reduction. In animals, chromium is an essential element for mammalian carbohydrate metabolism and is a cofactor for insulin. Its high concentrations in ribonucleic acid (RNA) have an unknown role. Its elimination half-life in rats is 0.5, 5.9, and 83.4 days. There is little information about or indication of bioaccumulation of chromium in either plants or animals. The trivalent form is more common in nature; the hexavalent form, which produces more adverse reactions, is reduced intracellularly to the trivalent form. Table 5.2-8 provides the critical exposure concentrations for chromium. As for cadmium, critical exposure concentrations for plants were based on a mean of NOAEL soil concentrations of toxic chromium (oxidation

from Gates (1988), Matsumura (1985), and Beyer et al. (1991). For plants, the critical exposure concentrations can be used without conversion. Site-specific daily dose (animals) or critical exposure concentrations (plants) can then be compared to a reference dose (animals) or critical exposure concentration (plants) to characterize ecological risk. The characterization of ecological risk is discussed in Section 5.2.6.

5.2.5.1 Toxicity of Metal Chemicals of Concern

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state not specified) for vegetables (Adema and Henzen 1989). For animals, a LOAEL diet value of trivalent chromium for ducklings (Eisler 1986) was used; this value was lower than the only value found in the literature for hexavalent chromium (see Appendix H).

Lead

Lead reduces plant growth, photosynthesis, mitosis, and water absorption. Perhaps as a result of these effects, it may reduce pollen germination and seed germination. In animals, lead tends to demyelinate axons in vertebrates, and in high doses it can reduce the numbers of young through spontaneous abortion and stillbirths and increase skeletal malformations. Lead has low bioavailability from soils and does not appear to bioaccumulate appreciably in plants. Information in the literature on the biomagnification of lead in higher levels of food webs is somewhat contradictory, but a number of studies show higher concentrations in higher trophic levels. Organic lead is more toxic than inorganic lead. Table 5.2-8 provides the critical exposure concentrations for lead. Critical exposure concentrations for plants were based on a general assumption that adverse effects seem to occur only at total concentrations of several hundred milligrams per kilogram of soil (Eisler 1988). For animals, the selected value was the lowest of several chronic oral doses that resulted in reduced survival of dogs (Eisler 1988). This value was only slightly higher than a sublethal value that caused behavioral abnormalities in monkeys; dogs were a more appropriate surrogate species (see Appendix H).

Mercury

In plants, mercury inhibits root growth. In animals, mercury may increase fetal anomalies, reduce fertility, and otherwise affect reproduction and behavior. Elemental mercury and alkylmercurials are more readily absorbed by plant roots than ionic inorganic mercury. The organic form, more prevalent in upper levels of food webs, is more toxic. Mercury biomagnifies significantly in food webs, with bioaccumulation factors ranging up to 14 for ducks and 22.5 for mammals (Heinz 1989; Wren et. al. 1987). Table 5.2-8 provides the critical exposure concentrations factors for mercury. Critical exposure concentrations for plants were based on a no observed adverse effects concentration for soil developed from a study of cucumbers (Siegel et al. 1971; Shariatpanahi and Anderson 1986). For animals, a LOAEL was used that resulted in impaired mallard reproduction (Heinz 1980) (see Appendix H).

state not specified) for vegetables (Adema and Henzen 1989). For animals, a LOAEL diet value of trivalent chromium for ducklings (Eisler 1986) was used; this value was lower than the only value found in the literature for hexavalent chromium (see Appendix H).

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Nickel

Nickel occurs naturally in plants. High concentrations may be lethal to some plant species, but tolerated by other species. In animals, nickel is present in herbivores and their predators, but does not appear to biomagnify. Table 5.2-8 provides the critical exposure concentrations for nickel. Critical exposure concentrations for plants were based on a lethal level for plants expressed as mg/kg dry weight (WHO 1991) and converted using a safety factor of 10 and a dry weight to wet weight conversion of 3.5 (Gish 1970). For animals, it was also necessary to use a lethal level, in this case based on a dose to rats (Hackett and Sunderman 1967) and converted using a safety factor of 10 (see Appendix H).

Silver

Silver appears to bioaccumulate in plants and has been shown to inhibit the action of ethylene on plants and thereby delay etiolation, abscission, and flower senescence in some plants. In animals, there is little evidence of silver bioaccumulation, except perhaps in the spleen. The major effect of absorption of excessive silver is the formation of insoluble complexes in elastic fibers. Table 5.2-8 provides the critical exposure concentrations for silver. No data were found to establish a critical exposure concentration of silver in plants. The critical exposure concentration for animals was based on a NOAEL for rats (Walker 1971) (see Appendix H).

Vanadium

Vanadium has been found in plants, but no data were found to document toxic effects. Vanadium tends to concentrate in oils and act synergistically with selenium. In animals, vanadium is found especially in fat and also in bones and teeth, but, at least in humans, appears to be excreted rapidly. It does not appear to biomagnify. It affects lung, kidney, liver, adrenals, bone marrow, and nerve tissues and may cause teratogenic skeletal abnormalities. Table 5.2-8 provides the critical exposure concentrations for vanadium. No data were found on toxic effects of vanadium in plants. The critical exposure concentration for animals was based on a LOAEL in rats (Kowalska 1988) (see Appendix H).

Zinc

Zinc is a micronutrient for plants and has a role in the synthesis of indoleacetic acid, a plant hormone, and in synthesizing proteins. Increasing concentrations may increase herbage production although they may ultimately become toxic to plant roots and crowns and cause growth reduction and chlorosis. In animals, zinc tends to concentrate in the kidneys, liver, and bone, and it may cause anemia, poor growth, and mortality. Most animals have a high tolerance

for zinc, perhaps because, like cadmium, it may be complexed with a protein and rendered less toxic. Zinc uptake is affected by the presence of other elements. The literature is unclear as to zinc biomagnification in food webs; some studies have found higher concentrations in higher trophic levels, but other studies have not. Uptake is poorly understood. Table 5.2-8 provides the critical exposure concentrations for zinc. The critical exposure concentration for plants was based on a LOAEL on grass from application to soil (White 1991). For animals, an LOAEL from a dose to mice (Aughey et al. 1977) was used (see Appendix H).

5.2.5.2 Toxicity of Nonmetal COCs

Cyanide is the single nonmetal COC. Cyanide is present in many chemical forms, any or all of which may be toxic. In plants, cyanide may enhance germination at low concentrations, and many species are cyanogenic, which serves as a defense against herbivores. However, at higher concentrations, cyanide inhibits respiration, ATP production, germination, and growth. In animals, sublethal concentrations, ingested especially from cyanogenic plants, may be tolerated for long periods. High concentrations can be lethal due to cyanide's action as an asphyxiant by inhibiting or stopping cellular respiration. Cyanide does not biomagnify and is rapidly detoxified in organisms. Table 5.2-8 provides the critical exposure concentrations for cyanide. No data were found on toxic effects of cyanide in plants. The critical exposure concentration for animals was based on a LOAEL in rats (Philbrick et al. 1979) (see Appendix H).

5.2.6 Ecological Risk Characterization

The critical exposure concentrations in Table 5.2-8 can be used to characterize potential ecological risk at SWMUs 1 and 25 by comparisons to average exposure concentrations at the site (Section 5.2.6.1) . The likelihood of such risk is influenced by the variability in COC concentrations across the two SWMUs and variability in a number of ecological parameters, as discussed in Section 5.2.6.2.The uncertainty associated with ecological risk characterization (see Section 5.2.7) must be remembered when interpreting the summary information and conclusions presented in Section 5.2.8.

5.2.6.1 Characterization of Potential Risk

If concentrations at the site exceed the critical exposure concentrations when both are expressed in comparable terms, then potential risk is likely. This comparison is made by calculating a hazard quotient (HQ) equal to the ratio of the COC concentration to its critical exposure concentration. Thus potential risk is likely if the HQ is greater than 1. The degree to which potential risk is likely is reflected in the magnitude of the exceedance.

In the calculation of HQ, site concentrations were represented by average surficial soil concentrations at SWMUs 1 and 25 combined. Soil concentrations were used because there is no surface water present on either SWMU and no exposure pathway to groundwater beneath the SWMUs. Surficial soil data were used because they better reflect the primary exposure of plants and animals, tended to be higher than subsurface values, and were consistently available. Additional subsurface soil will be collected and evaluated at a later date (see Section 1.1). Average values were used because, while chemical concentrations are variable in each of the SWMUs, plant root growth and animal mobility result in exposure to a range of COC concentrations.

For plants, the calculation of the HQ for each COC wa straightforward, as described above. The HQs calculated for plants are shown in Table 5.2-9 for each of the COCs.

For animals, the critical exposure concentrations provided in Table 5.2-8 are expressed in micrograms (μg) of COC per grams (g) of diet. Because animals vary in size and in the amount they eat per day, the concentration in diet must be converted to a dose that is expressed in terms of μg of COC per g of body weight (bw) per day. This conversion normalizes the critical exposure concentration for size and feed rate as is shown in the following example for cadmium:

$$RV_{animal} = \frac{2\ \mu g\ Cd}{g\ diet} * \frac{\frac{15\ g\ diet}{300\ g\ bw}}{day} = \frac{0.10\ \mu g\ Cd}{g\ bw\ day} \tag{5-5}$$

where RV is the reference value.

A comparable value was then calculated as an estimate of the actual dose received from the average surficial soil concentrations at SWMUs 1 and 25 (Table 5.2-9). Continuing with the cadmium example,

$$AID_{animal} = \frac{5.94\ \mu g\ Cd}{g\ soil} * \frac{0.063\ g\ soil}{g\ diet} * \frac{\frac{15\ g\ diet}{300\ g\ bw}}{day} = \frac{0.0187\ \mu g\ Cd}{g\ bw\ day} \tag{5-6}$$

Table 5.2-9 Comparison of Exposure Concentrations and Toxicity Reference Values

Contaminant of Concern	Average Surficial Soil Concentration (µg/g)	Calculated Average Site-Specific Dose from Soil Ingestion by Animals (AID)(µg/g bw/day)	(RV)[1] (µg/g bw/day for animals; µg/g for plants)	HQ (Ratio of AID to RV[2])
Cadmium				
Animal Comparisons	5.94	0.0187	0.10	0.19
Plant Comparisons	5.94	NA	15.1	0.39
Chromium				
Animal Comparisons	187	0.520	0.339	**1.5**
Plant Comparisons	187	NA	2.4	**78**
Lead				
Animal Comparisons	93.9	0.147	0.301	0.49
Plant Comparisons	93.3	NA	200	0.47
Mercury				
Animal Comparisons	0.0403	0.000112	0.0169	0.01
Plant Comparisons	0.0403	NA	2	0.020
Nickel				
Animal Comparisons	32.2	0.101	1.30	0.08
Plant Comparisons	32.2	NA	1.4	**23.0**
Silver				
Animal Comparisons	1.38	0.00435	65.0	0.000067
Plant Comparisons	1.38	NA	NA	NA

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Contaminant of Concern	Average Surficial Soil Concentration (µg/g)	Calculated Average Site-Specific Dose from Soil Ingestion by Animals (AID)(µg/g bw/day)	(RV)[1] (µg/g bw/day for animals; µg/g for plants)	HQ (Ratio of AID to RV[2])
Vanadium				
Animal Comparisons	23.3	0.0734	2.8	0.03
Plant Comparisons	23.3	NA	NA	NA
				??
Zinc				
Animal Comparisons	652	1.56	38.0	0.04
Plant Comparisons	652	NA	400	**1.63**
Cyanide				
Animal Comparisons	1.02	0.00321	30.0	0.000107
Plant Comparisons	1.02	NA	NA	NA

The source of RV values used in this table is identified in Sections 5.2.5.1 and 5.1.5.2, and is further discussed in Appendix H.

1 For animals, RVs are expressed as a dose in micrograms of chemical per gram of the animal's body weight per day.
For plants, RVs are expressed as a soil concentration in micrograms of chemical per gram of soil to which the plant is exposed.

2 A value less than 1.0 indicates that risk is unlikely because the concentration to which the organism is exposed is less than the dose believed to cause an effect. Values greater than 1.0 are bolded and indicate likely risk.

HQ Hazard quotient
RV Reference value
MG/G Micrograms per gram
PPM Parts per million
bw/day Body weight per day

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where AID is the average ingested dose, and the first two terms in this equation (i.e., the average concentration in soil multiplied by the dietary fraction of soil in the animals diet) are equivalent to the dietary concentration or first term in Equation 5-5. Table 5.2-9 shows the site specific doses resulting from this calculation for each COC and the HQs calculated for plants and animals.

Table 5.2-9 shows potential risk (i.e., HQ>1.0) to plants from chromium, nickel, and zinc; and to animals from chromium. Based on the magnitude of the HQ values shown in the last column of Table 5.2-9, potential risk was ranked as either low, moderate, or high, as shown in Table 5.2-10. The low ranking was assigned when the soil concentrations (or dose to an animal) were below the reference value. This indicates that the likelihood of adverse biological effects of the surficial soils is low. The moderate ranking was assigned when the soil concentration or dose was above the reference values by less than one order of magnitude. This ranking indicates that soil concentrations are at levels that may cause adverse biological effects, but may be within the range of uncertainty in the values. The high ranking was used when the soil concentrations or average ingested dose were one order of magnitude or higher than the reference values. Table 5.2-10 shows that the rankings for the risk to plants is high from chromium and nickel and moderate from zinc, while the risk to animals from chromium is moderate. There is low risk for all other COC/biota combinations since their HQs are less than 1.0.

In addition to risks from individual COCs, collective risk was evaluated by calculation of hazard indexes (HIs). HIs are likely to be conservative indicators of risk since the actions of various chemicals may be unrelated, synergistic or antagonistic as well as additive. The HIs that result from adding the individual HQ values for plants and animals indicate a high potential risk for plants and a moderate potential risk for animals.

5.2.6.2 Ecological Significance of Identified Potential Risk

The ecological significance of the potential risks that have been identified is influenced by the spatial distribution of the COCs in SWMU 1 and 25 soil, by the degree to which COC concentrations exceed background, and by ecological parameters that reflect variations in animal mobility and habitat affinity. These factors determine the degree to which various species may actually experience the potential risk that has been identified.

Table 5.2-10 Ecological Risk Ranking Relative to Average Surficial Soil Concentrations

	Ecological Risk Ranking	
Contaminant of Concern	Plants	Animals
Cadmium	Low	Low
Chromium	High	Moderate
Lead	Low	Low
Mercury	Low	Low
Nickel	High	Low
Silver	Unknown	Low
Vanadium	Unknown	Low
Zinc	Moderate	Low
Cyanide	Unknown	Low

Influence of COC Distribution Patterns

The spatial distribution of COCs across SWMUs 1 and 25 influences the ecological significance of the identified risks to plants and wildlife populations. The frequency of detections and average soil concentrations within the SWMUs are related to plant and animal reference values. Potential risk was calculated using the average soil concentration in both SWMUs combined and seems to imply that potential risk is present throughout the 334 acres (135 ha) of SWMU 1 and the 1257 acres (509 ha) of SWMU 25. However, the exceeding average soil concentration might be driven by several very high individual samples from a localized area. This would mean that the identified potential risk would have much less ecological significance because only a small number of sedentary individuals or a small proportion of the foraging area of more mobile individuals would actually experience risk. The effect on risk results of the spatial distribution of COC detections was investigated by comparing the risk results for combined SWMU 1 and 25 data to the results for the two SWMUs separately.

Chromium, nickel, lead, vanadium, and zinc were detected in all the samples (vanadium in 98 percent) and in all the source areas in SWMUs 1 and 25. This indicates that exposure to these metals is widespread. A comparison of plant and animal reference values to average surficial soil concentrations within the individual SWMUs revealed the same risk rankings as Table 5.2-10 for all COCs except zinc. For example, potential risk from chromium was ranked high for plants in both SWMUs 1 and 25, and moderate for animals in both SWMUs 1 and 25. For zinc, Table 5.2-10 reports a moderate risk to plants overall, while SWMU-specific soil concentrations result in potential risk to plants being low in SWMU 25 and moderate in SWMU 1. The potential risk to animals from zinc is low in both SWMUs.

Cadmium was detected in approximately one half the samples in each SWMU. Potential risk for plants and animals was ranked low in both SWMU 1 and SWMU 25.

Cyanide, mercury, and silver were detected less frequently (<33% detections) in both SWMUs, but all three COCs were detected more frequently in SWMU 25 than SWMU 1. Mercury was detected in less than 20 percent of the samples from either SWMU. The risk rankings for plants and animals from these COCs within each SWMU were similar to Table 5.2-10.

Background concentrations influence the ecological significance of potential risk because organisms present in an area must be adapted to the conditions there, including the metals concentrations that are present. Therefore, if a reference value for plants or the soil

concentrations that would result in a reference value for animals are lower than the background concentrations that are present, organisms are unlikely to be present, subject to the concentration variability and animal mobility that result in locally variable exposure.

Reference concentrations for plants are higher than surface background concentrations for cadmium, mercury, and silver; reference concentrations are lower than background for chromium, and nickel. Comparisons cannot be made for lead, vanadium, zinc or cyanide because one value or the other is missing. The soil concentrations that would result in a reference dose to animals (calculated by substituting the reference value for the average ingested dose in Equation 2 and solving for the COC concentration in soil) are higher than background soil concentrations except for nickel and perhaps for cyanide. Therefore, even in the absence of contamination (defined as the presence of concentrations that are higher than naturally occurring concentrations), plant species that are particularly sensitive to chromium and nickel and animal species that are particularly sensitive to nickel would likely not be present in at least some parts of SWMUs 1 and 25, or would have acclimated to the levels that are present. Except for mercury and vanadium, even average soil concentrations are higher than background concentrations for all the COCs (except that cyanide does not have an established background concentration).

Influence of Ecological Parameters

In evaluating the potential risk to plants from chromium, nickel, and zinc and to animals from chromium together with the distribution of these COCs across SWMUs 1 and 25, animal spatial and habitat requirements must be kept in mind. The spatial and habitat requirements of various animal groups must be related to the size of the SWMUs and the individual exposure areas present in the SWMUs, within the context of ecological threat to the TEAD-S ecosystem.

Typically, the foraging area of a species is smaller for lower trophic levels (e.g., small mammals use a foraging area about three orders of magnitude smaller than their predators). Thus, many individuals of prey species such as insects, rodents, and rabbits could inhabit SWMU 1 and 25, while only one or perhaps two individuals of their predator species might use the area. This means that a high or moderate potential risk for a widespread COC may equate to local populational effects on prey species, particularly when habitat is uniform across the SWMUs, a relatively lower risk to predators that do not range widely but nonetheless range more widely than their prey, and to only individual effects for wide-ranging predators.

The assumption of uniform habitat, however, is an over-simplification. Not all areas in the SWMUs are of equal habitat quality or type. Therefore, some areas may be occupied by fewer individuals of a certain species than others. The absence or lower quality of a habitat type may therefore reduce the number of individuals exposed in the population. In addition, species of raptors that are wide-ranging and hunt in open habitat (e.g., northern harrier) may be exposed to the SWMUs in a more uniform fashion than raptors that hunt in an area centered around a nest tree or perch (e.g., American kestrel). Therefore, in SWMUs 1 and 25, where few trees exist, exposure is much different for a northern harrier than it is for an American kestrel. To the extent that bald eagles use the perch tree north of SWMU 1 and east of SWMU 25 as a focal point for hunting forays, their exposure is also different from that of a northern harrier. These types of species-specific variations result in different ecological significance of the risks identified.

The other major ecological parameter that influences the ecological significance of the potential risk identified is the length of time spent in SWMUs 1 and 25. For wide-ranging predators such as raptors, variations in time spent are in part a response to habitat uniformity and quality and therefore the abundance of their prey. Prey species may be absent, patchy in their distribution, or less dense in their occupation of an area depending on the uniformity and quality of the habitat it provides. In addition, particularly for birds, the time spent in the SWMUs may vary by season. Some species may migrate through Tooele, or may spend only the summer or winter there, while others may be permanent, year-round residents. Large game mammals also migrate, although their free movement is constrained by the Tooele fences, which do not impede bird use of the area. Finally, there are population expansions or replacements at the end of every breeding season, so the individuals that are in a given locale during one time period may later move. The calculations of potential risk assume year-round exposure and so are conservative for the individuals of many species.

5.2.7 Uncertainty in Potential Risk Characterization

There are several sources of uncertainty associated with the characterization of potential risk to plants and animals from chemicals present in SWMUs 1 and 25. These include uncertainties inherent in the representation of exposure concentrations, uncertainties from the assumption that ingested soil is the only source of COC concentrations, uncertainties in the literature values used, and uncertainties relative to the chemical form and availability of the COCs at SWMUs 1 and 25.

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5.2.7.1 Representation of Exposure Concentrations

The use of average surficial soil concentrations as the basis for exposure leaves uncertainty relating to risks of exposure to of "hot spots" versus relatively clean areas. A gradient of soil concentrations across the SWMUs could not be developed from the soil samples because of the soil sampling design. This uncertainty is of minimal ecological significance, so long as the hot spots are small, for the following reasons. Small isolated hot spots for COCs are of little ecological consequence because such source areas are relatively small when compared to the area needed to support a population of many of the target receptors. Thus, any potential high risk areas would be likely to result in adverse effects to only a few individuals of a species such as small mammals that forage over a small area. This individual loss would be of little consequence to the small mammal population at large. The individuals of more wide-ranging species are most likely to be exposed to COC concentrations in the soils throughout their foraging area, i.e., to average concentrations rather than to isolated hot spots. Therefore, the use of average soil concentrations across the SWMUs as an estimate of exposure concentration is generally valid for estimating risk to populations of relatively sedentary species and to individuals of wide-ranging species. The population of relatively sedentary species and the individuals of wide-ranging species tend to be exposed to average soil concentrations.

5.2.7.2 Assumption of Ingested Soil as the Only Chemical of Concern Source

The assumption that ingested soil is the only source of COC concentrations ingested by animals ignores concentrations that may be ingested from surface water and in the prey of predators that are higher in the food web. Ingestion of COCs in surface water is likely to be inconsequential because of the virtual absence of surface water in SWMUs 1 and 25 and its paucity on TEAD-S as a whole. Six of the nine COCs (cadmium, chromium, lead, mercury, nickel, and zinc) may be bioaccumulative in plants or animals (Table 5.2-11). Thus, this assumption may underestimate potential risk because bioaccumulative COCs are likely to be present in prey items as well as in ingested soil. Two types of information aid in evaluating the degree to which bioaccumulative COCs may have been underestimated in the dose for higher predators: the bioaccumulation factor (BAF) and the assimilation fraction (AF). The BAF and AF values that were found in the literature for the COCs are listed in Table 5.2-11.

Bioaccumulation is the ratio of the concentration of a COC in a predator to its concentration in the predator's collective prey. Therefore, the BAF provides a measure of the degree of underestimation of risk between one trophic level and the next higher level. It can be seen from Table 5.2-11 that mercury BAF values are the highest for plants and are the only values found

Table 5.2-11 Information to Aid in Assessing Risk Underestimation*

Contaminant of Concern	Bioaccumulation Factor Values: Plant	Bioaccumulation Factor Values: Animal	Animal Assimilation Fraction
Cadmium			0.0025
Chromium	0.00025		<0.005
Lead			0.08
Mercury	0.45	bird maximum, 14 mammal maximum, 22.5	
Nickel	0.019		0.3
Silver	0.15		0.01
Vanadium			0.02
Zinc	0.4		0.1
Cyanide			

* All values taken from Whicker and Schultz (1982)

in the literature for vertebrates, for which they range as high as 23. Since mercury was also noted in Section 5.2.5 to bioaccumulate more than the other COCs, it provides a worst-case example. The plant BAF value are less than 1.0, which means that mercury concentrations in plants should be less than in soil. Ingestion of plants containing mercury will, therefore, add mercury to the ingested dose for herbivores, but at less than half the rate as ingested soil. Mercury concentrations in predators that eat these herbivores, however, could be 23 times greater than the mercury concentrations in the herbivores. This 23-fold increase in contaminant concentration could occur again for the next higher trophic level in this worst-case scenario. To evaluate mercury bioaccumulation for SWMUs 1 and 25, the soil concentration necessary to result in the reference dose value for mercury was compared to the actual mean exposure soil concentration in the SWMUs. The necessary soil concentration was back-calculated in equation (2) above by setting the AID equal to the RV and solving for soil concentration. As this back-calculated soil concentration is approximately 150 times higher than the average SWMU value, several 23-fold trophic level bioaccumulations can be accommodated before this underestimation of dose is likely to result in potential risk at SWMUs 1 and 25.

The other aid in assessing the degree of underestimation of risk between trophic levels is the assimilation fraction. This fraction indicates the proportion of the ingested COC concentration that is actually assimilated into the predator's tissues. The low values for the available assimilation fractions diminish the likelihood of underestimated risk. The low values mean that most of the COC concentration ingested by an animal will not be assimilated into its tissues.

5.2.7.3 Uncertainties in the Literature Values Used

The literature values used to determine toxic levels at SWMUs 1 and 25 were primarily based on vegetables, grasses, rodents, ducks and dogs. These subjects must act as surrogates for the wide array of plants and animals at TEAD-S. The use of surrogate species introduces uncertainty to the reference values used for plants and animals because the values used may not be representative of the average species, the average individual in that species, or the average individual in the most sensitive species. For example, too few replicates were studied to quantify the range, mean, and variance of a particular parameter; often only a single value was available.

5.2.7.4 Uncertainties Due to Chemical Variations

Chromium and mercury are found in several chemical forms that differ in their degree of toxicity, occurrence, and bioavailability in soil. As stated in Section 5.2.5.1, the trivalent form of

chromium is more commonly found in nature, and the less common hexavalent form is potentially more toxic. In the evaluation of potential ecological risk from chromium, the assumption that only the hexavalent form was present resulted in the risk to plants being ranked as high and the risk to animals being ranked as moderate. Similarly, for mercury, organic mercury is more toxic than inorganic mercury and organic mercury is less common in nature than inorganic mercury. Thus, the use of values for the more toxic form of these metals is likely an over estimation of potential risk because, while the forms and availability of these COCs in the SWMUs are unknown, they are likely to be less common than the less toxic forms. In addition, the potential risk from cyanide, silver and vanadium to plants is unknown because reference values for plant toxicity were not found in the literature.

5.2.8 Summary and Conclusions

The most likely exposure from contaminants at SWMUs 1 and 25 was determined to be through contact and ingestion of surficial soil (top 1 foot). Through the use of exposure and toxicological criteria, nine metals (cadmium, chromium, lead, mercury, nickel, silver, thallium, vanadium, and zinc) and cyanide were selected as chemicals of concern (COCs) for biota. For these nine COCs, the scientific literature was searched for reference values that define the concentration at which a dose of the COC results in adverse effects to the test organism.

Rankings of potential risk from each COC were established as either low, moderate, or high by comparing exposure concentrations to reference values for both plants and animals. Because exposure concentrations were estimated by surficial soil concentrations averaged across SWMUs 1 and 25, these potential risk rankings were for the entire area comprised of both SWMUs. Chromium risk was ranked high for plants and moderate for animals. Risk from nickel and from zinc to plants was also ranked moderate.

When SWMUs 1 and 25 were evaluated separately, risk rankings were the same as those derived for the SWMUs together for all COCs except zinc. This indicates widespread distribution of the high and moderately ranked COCs. Zinc had low risk for plants in SWMU 25 and moderate risk for plants in SWMU 1. The ecological significance of small areas of high concentration is minimal because only resident individuals of relatively sedentary species would be affected by them; populations of more sedentary species and individuals of more wide-ranging species are unlikely to be affected by small areas of high concentration.

The uncertainties inherent in this assessment of potential risk result from the following:

- Use of average soil concentrations
- Assumption that soil ingestion was the only significant source of contaminant uptake in animals
- Use of toxicological reference values based on surrogate species
- Unknown chemical forms and availability of the COCs in the surficial soils

Some of these uncertainties tend to result in an underestimation of potential risk (e.g., assuming ingested soil is the only contaminant source for animals), some tend to overestimate potential risk (e.g., using reference values for the more toxic chemical form when it is not the most prevalent in nature), and some of these uncertainties have an unknown effect on potential risk estimates. The underestimation of risk appears to be a problem only to organisms that are two or more trophic levels above herbivores.

In conclusion, there is potential ecological risk from chromium, nickel, and zinc in the surficial soils at SWMUs 1 and 25. These potential risks must be considered in the context of the uncertainties inherent in their estimation. They are of particular concern with respect to higher trophic level carnivores (e.g., peregrine falcon), particularly if these receptors are year-round residents (e.g., great horned owl).

6.0 SUMMARY AND CONCLUSIONS

The RFI-Phase II of SWMUs 1 and 25 and the RFI-Phase I of SWMU 37 included historical research, site inspection and munitions inventory, ecological habitat and key species identification, and soil, water, and air sampling and analysis. The results form the basis of a human health and ecological risk assessment of SWMUs 1 and 25 and a contamination assessment of SWMU 37. The conclusions of these assessments are summarized below.

6.1 SWMUS 1 AND 25

SWMUs 1 and 25 were used from the 1940s until the 1970s for agent, incendiary, and high-explosive ordnance demilitarization. In several demilitarization or disposal areas within these SWMUs, soil, groundwater, and air quality samples contained low levels of a few organic compounds and elevated levels of many metals. A human health and ecological risk assessment was performed to evaluate the potential risks associated with these contaminants.

Limitations were imposed on the risk assessment because subsurface soil could not be sampled at this stage of the RFI in SWMU 1 and parts of SWMU 25. Subsurface sampling and excavation in these potentially agent-contaminated areas is postponed until the Army completes the formulation of policies and procedures that will allow this type of contamination to be handled and disposed of safely.

The subsurface soil sampling restriction for SWMU 1 and part of SWMU 25 prevented characterization of soil below the 2-inch depth interval or any soil in open disposal trenches below munitions debris that may have contained or been contaminated by agent. It also prevented excavation of any closed trenches where agent disposal may have occurred. These limitations have little effect on the evaluation of risks associated with current uses of TEAD-S, as the samples can be used to characterize surface soil contamination that could result in dermal or inhalation exposures of workers who currently enter these SWMUs or work near them. However, without subsurface soil data, no realistic risk evaluation could be performed for future use scenarios. The risk assessment will be expanded when these additional data are available.

Detected organics included two phthalates, several polynuclear aromatic hydrocarbons associated with fuel burning, an explosive compound, pesticides, and one nerve agent breakdown product. Most of these organic analytes were found in only one soil sample each. Since these contaminants were not widespread, they were not selected as COCs to be carried through the risk

characterization. Sixteen metals and cyanide were evaluated in the human health risk assessment, and eight metals and cyanide were evaluated in the ecological risk assessment.

6.1.1 Human Health Risk Assessment Conclusions

The human health risk assessment evaluated risks to human receptors having the highest potential exposures to soil and groundwater COCs at SWMUs 1 and 25. Cancer risks and noncancer hazard indices (HIs) were calculated for the following current-use receptor scenarios:

- Ingestion, dermal contact and inhalation exposures to surface soil COCs at SWMUs 1 and 25 by site security personnel and maintenance workers (on-site scenarios)

- A worst-case evaluation of potential inhalation exposures to surface soil COCs by CAMDS workers, assuming wind dispersal of soil particulates to the off-site CAMDS facility

- A worst-case evaluation of potential exposures to groundwater COCs through the food chain (consumption of meat and dairy products) by local residents, assuming use of the downgradient Stookey well for stock watering purposes

Results of these current-use evaluations indicate the following:

- For the on-site soil exposure scenarios (site security/maintenance worker receptors), total cancer risks calculated for both SWMUs are at the lower bound of the (10^{-6} to 10^{-4}) risk range requiring site controls as stated in State of Utah rules. Noncancer HIs are less than the corrective action HI criterion of 1.0.

- Inhalation risks calculated for the assumed downwind CAMDS worker receptors are well within acceptable risk criteria for both cancer and noncancer endpoints (i.e., cancer risks are below 10^{-6} and HIs are well below 1.0)

- The carcinogenic risk result for the worst-case groundwater/plant/food-chain scenario indicates that either site controls or monitoring are required under Utah rules. The noncancer HI for this pathway is less than the corrective action criterion. The cancer risk result should be interpreted in light of the fact that the actual presence and concentrations of groundwater COCs in this well are unknown. Furthermore, there is no evidence that this well is actually in use.

The human health risk assessment also evaluated the following hypothetical future-use exposure scenarios:

- Exposures to surface soil COCs at SWMUs 1 and 25 by future (farm family) residents (via ingestion, dermal contact, inhalation, and food consumption pathways)
- Exposures to groundwater COCs by future residents (via ingestion and volatile inhalation pathways)

Results of these future-use evaluations are as follows:

- Total cancer risks calculated for soil exposures under the future-use residential/agricultural scenario are within the (10^{-6} to 10^{-4}) range of risks requiring only site controls. Noncancer HIs exceed the target criterion for both SWMUs 1 and 25. These exceedances are attributable primarily to background levels of thallium in soil and thus are not considered noteworthy.
- The cancer risk and HI calculated for the future-use groundwater exposure pathway (assuming potable/domestic uses) both exceed risk criteria requiring corrective action. However, groundwater underlying SWMUs 1 and 25 is not currently used as a potable water source due to its salinity and low production capacity; these conditions are not expected to change in the future.

The results of the future-use risk evaluations should be interpreted in light of the hypothetical nature of the residential/agricultural use scenario, and the extent to which background levels of soil and groundwater COCs contribute to the cancer risk and HI estimates. Because future residential use of TEAD-S is not anticipated, the residential scenario was presented for comparison purposes only, and will not be used as the basis for any subsequent risk management decisions. As indicated above, the results of the human health risk assessment conducted for current (actual) conditions are at the lower bound of the risk range requiring only site controls, and indicate no potential health threats stemming from exposure to constituents in soil or groundwater at TEAD-S Group 1 SWMUs.

6.1.2 Ecological Risk Assessment Conclusions

The ecological risk assessment screened risks associated with eight metals and cyanide and assigned a low, moderate, or high ranking to each. The chromium risk was ranked high for plants and moderate for animals. Nickel and zinc risks were ranked high for plants. These risks are of concern mainly with respect to higher trophic level carnivores, especially those that are year-round residents of TEAD-S or its surroundings.

6.1.3 Explosive Risk Determination Conclusions

There is risk associated with the physical hazard of live explosives in SWMUs 1 and 25. The UXO and bulk explosives observed along transects included in the RFI-Phase II of SWMUs 1 and 25 are documented in Tables 4.1-1 and 4.1-2. These tables rank risk from none to high at each disposal feature or other location along the UXO inventory transects. The risk ranking was assigned according to the type of UXO observed and its condition. Low and medium risks were assigned to most of the disposal features because of the presence of apparently demilitarized ordnance. High explosive risk was assigned where bulk explosives or UXO was found. On this basis, high explosive risk was assigned to portions of both SWMUs 1 and 25. However, as travel through these areas is limited to occasional entry by TEAD workers with training in UXO recognition and avoidance, the risk of explosion is remote under conditions of present use by Army personnel.

6.1.4 Recommendations for SWMUs 1 and 25

The human health risk assessment of SWMUs 1 and 25 under conditions of current use by Army personnel indicates no cleanup of the soil in this area is required. However, these conclusions are preliminary since the potential for agent contamination prevented examination of ordnance or other debris in open disposal pits, excavation of closed disposal pits, or subsurface soil sampling in SWMU 1 or parts of SWMU 25.

As stated above, the Army is in the process of formulating policies that will allow safe excavation and handling of agent-contaminated soil and other wastes. When these policies are available for use, the SWMU 1 and 25 sampling program and risk assessment will be expanded. The results of this future risk assessment will be used to determine the need for a corrective measure study of these SWMUs. The corrective measure study will also address the action that should be taken to remove or destroy unexploded ordnance documented in SWMUs 1 and 25 during the RFI-Phase II field program.

Since the preliminary ecological risk assessment identified potential risks to the environment associated with certain metals in SWMUs 1 and 25, this assessment should be expanded into a quantitative characterization of ecological risk. To support this quantitative assessment, biota samples should be collected to establish the levels of COCs that are present in wildlife in this area.

6.2 SWMU 37

SWMU 37 consists of slag or ash piles, bomb fragments, and incendiary bomblets located in a gravel pit. Since SWMU 37 was not listed in the CSDP permit corrective action module during the time of the RFI-Phase I field program of the other suspected releases units, the RFI-Phase I at this SWMU was conducted during the Phase II investigation of SWMUs 1 and 25. This RFI-Phase I was designed to determine the presence or absence of contamination at SWMU 37 and to support a recommendation of either no further action or a Phase II investigation.

6.2.1 Contamination Assessment Conclusions

The RFI-Phase I samples indicated no significant organic contamination. However, several metal results were above background in surface and subsurface samples, especially in an area of backfilled soil in the western part of the gravel pit. The vertical extent of these elevated metals concentrations was not delineated by the samples, which were collected from a maximum depth of 2.5 ft. However, the detected concentrations were below action levels developed for a proposed rule on Corrective Action for SWMUs (40 CFR 264, Subpart S). There are no corrective action levels for some of the detected metals. A sample of the slag and ash analyzed for RCRA characteristics showed that this material is not a RCRA characteristic waste.

The RFI-Phase I at this SWMU did not include a detailed inventory of unexploded ordnance such as was performed at SWMUs 1 and 25. However, in addition to inert bomb fragments in the northern part of the gravel pit, intact incendiary bomblets were observed on and around the road leading down the north side of the pit.

6.2.2 Recommendations for SWMU 37

Although none of the elevated metal concentrations exceeded the action levels in the proposed rule on corrective action, further sampling is recommended at SWMU 37 to define the extent of elevated metal concentrations in the backfilled material. However, the slag and ash and all ordnance should be removed and disposed of properly.

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APPENDIX A

FIELD DATA

- **A1** **Boring Logs, Well Construction Logs, and Well Development Records**
- **A2** **Water Quality Field Data Sheets**
- **A3** **Geotechnical Data**

APPENDIX A1

Boring Logs, Well Construction Logs and Well Development Records

APPENDIX A1

Notes:

1) The boring logs for the following locations are not included within this appendix because they were not generated at the time of sample collection:

   01-IAM-8
   01-IAM-11
   01-IBA4
   01-DA-441 (material sample)
   25-CT-52
   25-MA1
   25-MA2
   25-NIA-52

2) The two sample depth intervals (4-5 feet and 9-10 feet) for location 25-IBA-60 are included in the boring log for monitoring well S-100-92.

3) The boring logs, well construction forms, and well development records for the following Phase II monitoring wells are included in this appendix:

   S-93-92
   S-95-92
   S-96-92
   S-97-92
   S-98-92
   S-99-92
   S-100-92
   S-101-92
   S-102-92

   The information pertaining to monitoring wells installed prior to Phase II can be found in the RFI-Phase I report.

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Sketch Map/Notes

Field Bore Log

Site Type Grab
Site ID G1-CBA-8 Dia. of Hole N/A
Date/Time Started 11/12/92 1120
Date/Time Completed 11/12/92
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth (~~ft.~~) BW 4/6/93 0-2"
Drilling Company ~~Boyles Bros.~~ BW 4/6/93 No. Samples 1
Drilling Method HAND DUG
Driller Ryan O'Connell
Geologist/Date Jon Coen (Signature) 1/12/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2'	0-2"		10YR 3/1	v. fine to small pebbles; poorly sorted; Pebbles are rounded to subangular, slightly moist; minor organic matter.

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Sketch Map/Notes

Field Bore Log

Site Type Composite - Grab Site ID 01-CBA-30 Dia. of Hole N/A
Date/Time Started 11/11/92 1010 Date/Time Completed 11/11/92 1010
Surface Elevation N/A Water Level: Initial (ft.) N/A
Completion Depth (ft.) 0-2" Drilling Company ~~Boyles Bros.~~ No. Samples 1
Drilling Method HAND DUG Driller Ryan O'Connell
Geologist/Date [signature] (Signature) 1/12/93 Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		2.5Y 5.2	V. Fine to medium sand, moderately sorted, grayish Brown, subrounded to subangular, small rootlets

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil - Grab Site ID 01-CP-44 Dia. of Hole NA
Date/Time Started 11/10/92, 1100 Date/Time Completed 11/10/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ sw 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ sw 4/6/93 No. Samples 1
Drilling Method Hand dug Driller R. O'Connell
Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med grained sand, some coarse to very coarse sand; some clay to silt; angular to subangular; moderately sorted; color: 10YR 6/3; some caliche; limestone sand
5							
10							
15							

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Sketch Map/Not

Field Bore Log

Site Type Surficial Soil - Grab Site ID 01-CP-63A Dia. of Hole NA
Date/Time Started 11/10/92, 0915 Date/Time Completed 11/10/92
Surface Elevation Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand Dug Driller Mark Brooker, Tooele Depot
Geologist/Date R. J. Canon Checked by/Date
(Signature) 1/12/9~~2~~3 RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to med grained sand; some clay and silt; some coarse to very coarse sand; trace granule; moderately sorted; angular to sub-angular; color: 10YR 5/2; trace to some caliche; limestone sand
5							
10							
15							

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RTC 1/12/92
(NW corner of mustard Holding Area)

Field Bore Log

Sketch Map/Notes

Site Type Surficial Soil, Grab
Site ID 01-CP-89B
Dia. of Hole NA
Date/Time Started 11/11/92 1355
Date/Time Completed 11/11/92
Surface Elevation
Water Level: Initial (ft) NA
RTC 5/10/93
Completion Depth (ft) 2 inches
Drilling Company ~~Boyles Bros.~~
No. Samples 1
Drilling Method Hand dug
Driller Ryan O'Connell
Geologist/Date R. J. Canon (Signature) 1/12/93 RTC 5/10/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; silty; clayey; very fine to med. grained sand; some coarse to very coarse; angular to subangular; moderately sorted; color: 2.5Y 5/2; some caliche
5							
10							
15							

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Sketch Map/Note

Field Bore Log

01-DA-442
~~01-DA-44-2~~ [initials] 9-3-93

Site Type Surficial Soil - Grab Site ID ________ Dia. of Hole NA

Date/Time Started 11/10/92, 1000 Date/Time Completed 11/10/92

Surface Elevation ________ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand Dug Driller Ryan (?) O'Connell

Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ________ RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sa[nd]; some silt & clay, some coarse to very coarse sand; limestone sand; angular to subangular; moderately sorted; color: 10YR 5/2
5							
10							
15							

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Sketch Map/Notes

(IDF 84)

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-HBA-84 Dia. of Hole NA
Date/Time Started 11/9/92, 1035 Date/Time Completed 11/9/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AMV 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AMV 4/6/93 No. Samples 1
Drilling Method Hand dug Driller Ryan (?) O'Connell
Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sand, much clay and silt; some coarse to very coarse grained sand; angular to sub-angular; moderately sorted; limestone sand; color: 10YR 6/3
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

(IDF 85, next to Barrels)

Site Type Surficial Soil, Grab Site ID 01-HBA-85 Dia. of Hole NA
Date/Time Started 11/9/92, 0955 Date/Time Completed 11/9/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth (~~ft~~) 0-2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1
Drilling Method Hand dug Driller Ryan O'Connell (Tooele Depot)
Geologist/Date R. J. Canon (Signature) Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to fine grained sand silty; some clay; some med. grained, trace coarse grained sand; angular to subangular; moderately sorted; Color: 10YR 5/3; some caliche; limestone sand

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Sketch Map/Notes

(IDF 92)

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-HBA-92 Dia. of Hole NA
Date/Time Started 11/9/92, 1130 Date/Time Completed 11/9/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller Mark Brooker
Geologist/Date R. T. Canon (Signature) 1/12/93 Checked by/Date ______
RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; silty, clayey; very fine to fine grained sand; some med grained sand; angular to subangular; limestone sand; moderately sorted; Color: 2.5Y 5/4; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-HBA-93 Dia. of Hole NA
Date/Time Started Nov. 1992 Date/Time Completed Nov. 1992
Surface Elevation Water Level: Initial (ft.) NA
Completion Depth (ft.) 2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1
Drilling Method Hand dug Driller ?
Geologist/Date R.T. Canon (Signature) 1/12/93 Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sand; some clay + silt; some to trace coarse to very coarse sand; angular to subangular; moderately sorted; burnt (charcoal) wood chips; Color: 5Y 4/2; caliche(?) present

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-IA-60 Dia. of Hole NA
Date/Time Started 11/1/92, 1710 Date/Time Completed 11/1/92
Surface Elevation ____ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 1/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 1/6/93 No. Samples 1
Drilling Method Hand dug Driller Ryan O'Connell
Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ____

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sand; some silt and clay; some coarse to very coarse grained sand; angular to subangular; moderately sorted; color; 5Y2.5/1; looks incendarated

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Sketch Map/Notes

Field Bore Log

Site Type Composite - Grab Site ID 01-IA-80 Dia. of Hole N/A

Date/Time Started 7/11/92 1220 Date/Time Completed 7/11/92 1220

Surface Election ______ Water Level: Initial (ft.) N/A

Completion Depth (~~ft.~~) AW 4/6/93 0-2" Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method HAND DUG Driller Ryan O'Connell

Geologist/Date Jon Coen (Signature) Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		10YR 3/2	silty to medium sand w/ minor coarse sand and small pebbles; very dark grayish brown; grains are subrounded to subangular

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Sketch Map/Notes

Field Bore Log

Site Type CRAB
Site ID 61-IA-88
Dia. of Hole N/A
Date/Time Started 7/11/92 1635
Date/Time Completed 7/11/92 1635
Surface Elevation
Water Level: Initial (ft.) N/A
Completion Depth (~~ft.~~) 0-2" AW 4/6/93
Drilling Company ~~Boyles Bros.~~ AW 4/6/93
No. Samples 1
Drilling Method Hand Dug
Driller Ryan O'Connell
Geologist/Date Jon Coen (Signature) 1/12/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		7.5YR 4/4	Brown/Dk brown - very fine to coarse sands, v. small pebbles, charcoal, slightly moist in JAR; grains are sub angular to subrounded.

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Sketch Map/Notes

Field Bore Log

Site Type GRAB
Site ID 01-IAM-13 Dia. of Hole N/A
Date/Time Started 11/11/92 1610
Date/Time Completed 11/11/92 1610
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth ~~(ft)~~ AW 1/6/93 0-2"
Drilling Company ~~Boyles Bros.~~ RO 1/12/93
No. Samples 1
Drilling Method HAND DUG
Driller Ryan O'Connell
Geologist/Date Jon Coen (Signature) 1/12/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		2.5Y 5/2	grayish Brown, small Rock fragments mixed w/ v. fine to coarse sand, poor to moderately sorted; small roots, dr wood fragments.

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Sketch Map/Notes

Field Bore Log

Site Type Grab
Site ID 01-JAN-15 Dia. of Hole N/A
Date/Time Started 11/11/92 1535
Date/Time Completed 11/11/92 1535
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth (ft) 0 - 2"
Drilling Company ~~Boyles Bros.~~ 1/12/93
No. Samples 1
Drilling Method HAND DUG
Driller Ryan O'Connell
Geologist/Date Jon Coren (Signature) 1/12/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		2.5Y 4/4 SM	Light olive brown cemented sands v. fine to medium sands, small rock fragments, subrounded to subangular.

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Sketch Map/Notes

Field Bore Log

Site Type: Composite
Site ID: ~~01-IBA-1~~ 01-IBA1 9-3-93
Dia. of Hole: N/A
Date/Time Started: 11/11/92 1450
Date/Time Completed: 11/11/92 1450
Surface Elevation: N/A
Water Level: Initial (ft.): N/A
Completion Depth (ft.): 0-2" AW 4/6/93
Drilling Company: ~~Boyles Bros.~~ etc
No. Samples: 1
Drilling Method: HAND DUG
Driller: Ryan O'Connell
Geologist/Date: (Signature) 1/12/93
Checked by/Date:

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		2.5Y 4/4	Olive Brown, moderately sorted v. fine to med sand; minor pebbles up to 1/2" Diameter; subrounded to subangular; small debris/grasses mixed in.

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Sketch Map/Notes

Field Bore Log

Site Type GRAB
Site ID ~~01-IBA2~~ 01-IBA2 9-3-93
Dia. of Hole N/A
Date/Time Started 11/11/92 1645
Date/Time Completed 11/11/92 1645
Surface Elevation N/A
Water Level: Initial (ft.)
Completion Depth ~~(ft)~~ AW 4/6/93 0-2"
Drilling Company ~~Boyles Bros.~~ AW 4/6/93
No. Samples 1
Drilling Method HAND DUG
Driller Ryan O'Connell
Geologist/Date Jon Coler (Signature)
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		10YR 4/2	moderate to poorly sorted - v. fine to moderate (medium) sand with sparse pebbles ~~of~~ of varying size. Pebbles are subrounded to subangular; small rootlets are present.

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Sketch Map/Not

Field Bore Log

- Grab 01-IBA3 ~~01-IBA~~ 3 ~~TUM~~ 9-3-93

Site Type Surficial Soil Site ID ~~01-IBA~~ Dia. of Hole NA

Date/Time Started 11/12/92 Date/Time Completed 11/12/92

Surface Elevation Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand dug Driller

Geologist/Date Travis Canon (Signature) 1/8/93 Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to fine grained, to some med. to very coarse grained; occassional granule; limestone sand; trace caliche (visible); angular to subangular; color: 10YR 5/3; poorly-moderately sorted
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

01-MHA1
~~01-MHA~~ 1 9-3-93

Site Type Surficial Soil, Grab
Site ID
Dia. of Hole NA
Date/Time Started 11/11/9~~2~~3, 1200 RTC 5/10/93
Date/Time Completed 11/11/9~~2~~3 RTC 5/10/93
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (~~ft~~) 4/6/93 2 inches
Drilling Company ~~Boyles Bros.~~ 4/6/93
No. Samples one
Drilling Method Hand dug
Driller Ryan O'Connell, Tooele Depot
Geologist/Date A. T. Canon (Signature) 1/12/9~~2~~3 RTC 5/10/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; silty; clayey; very fine to fine grained sand; some med - coarse grained sand; trace granules; angular to subangular; moderately sorted; some caliche; Color: 10YR 6/2 limestone sand

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Sketch Map/Notes

Field Bore Log

MAU 9-3-93

Site Type Surficial Soil, Grab Site ID 01-MHA02 Dia. of Hole NA
Date/Time Started 11/11/92, 1245 Date/Time Completed 11/11/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller Ryan O'Connell
Geologist/Date A. T. Canon (Signature) 1/12/93 Checked by/Date ______ RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; clayey; silty; very fine to fine grained sand; some med. grained; angular to subangular; moderately sorted; color: 2.5Y 4/3; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-MHAU Dia. of Hole NA
Date/Time Started 11/11/92, 1110 Date/Time Completed 11/11/92
Surface Elevation ____ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller Ryan O'Connell
Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ____

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; clayey; silty; very fine to fine grained sand; some med. grained; angular to subangular; moderately sorted; color: 2.5Y 4/4; some caliche

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(IDF82 Mortar Pit)

Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil- Grab Site ID 01-MP-82 Dia. of Hole NA

Date/Time Started 11/10/92, 1255 Date/Time Completed 11/10/92

Surface Elevation ______ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand Dug Driller R. O'Connell

Geologist/Date R. T. Canon (Signature) 1/12/9~~2~~3 Checked by/Date ______

RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sand some silt and clay, some coarse to very grained sand; moderately sorted; angular to subangular; trace to some caliche; color: 10YR 6/3; limestone sand
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soils, Grab   Site ID 01-MP-89   Dia. of Hole NA

Date/Time Started 11/8/92, 1040   Date/Time Completed 11/8/92

Surface Elevation ____   Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ 2 inches   Drilling Company ~~Boyles Bros.~~   No. Samples 1

Drilling Method Hand dug   Driller Ryan O'Connell

Geologist/Date R. T. Canon (Signature)   Checked by/Date ____

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to med grained sand; silty and clayey; moderately sorted; angular to subangular; limestone sand; color: 2.5Y 7/3; some caliche

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Sketch Map/Notes

Field Bore Log (NE side of IDF 89)

Site Type Surficial Soil, Grab Site ID 01-MP-89A Dia. of Hole NA

Date/Time Started 11/8/92, 1410 Date/Time Completed 11/8/92

Surface Elevation ______ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 3/16/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand dug Driller Ryan (?) O'Connell

Geologist/Date R. J. Canon (Signature) 1/12/9~~2~~3 RTC 5/10/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to fine grained sand some med. grained; silty and clayey; trace coarse to very coarse grained sand; angular to subangular; moderately sorted; limestone sand; color: 10YR 4/2; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type: Surficial Soil, Grab
Site ID: 01-MP-89B
Dia. of Hole: NA
Date/Time Started: 11/8/92, 1200
Date/Time Completed: 11/8/92
Surface Elevation:
Water Level: Initial (ft.) NA
Completion Depth (~~ft.~~) 2 inches (RW 4/6/93)
Drilling Company: ~~Boyles Bros.~~ (RW 4/6/93)
No. Samples: 1
Drilling Method: Hand dug
Driller: Ryan O'Connell
Geologist/Date: R. J. Canon (Signature) 1/12/9~~2~~3 RTC 5/10/93
Checked by/Date:

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; silty; clayey; very fine to fine grained sand; some to trace coarse grained sand, granules, and small ~~be~~ pebbles; angular to subangular; moderately sorted; limestone sand; color: 10YR 4/3 (RTC 1/12/92)

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-MP-89C Dia. of Hole NA
Date/Time Started November 1992 Date/Time Completed November 1992
Surface Elevation ________ Water Level: Initial (ft) NA
Completion Depth ~~(ft)~~ AW 4/16/93 2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1
Drilling Method Hand Dug Driller ?
Geologist/Date R. T. Canon (Signature) 1/12/93 Checked by/Date ________

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to medium grain sand; some to much silt and clay; some med. to coarse grained; subangular to angular; moderately sorted; limestone sand; some caliche; color: 2.5Y 5/3
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

(East of IDF89)

Site Type Surficial Soil, Grab
Site ID 01-MPVU1 ~~01-MPVU~~ 9-3-93
Dia. of Hole NA
Date/Time Started 11/8/92, 1125
Date/Time Completed 11/8/92
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (~~ft.~~) 2 inches
Drilling Company ~~Boyles Bros.~~
No. Samples 1
Drilling Method Hand dug
Driller Ryan O'Connell
Geologist/Date R. T. Canon (Signature)
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to med. grained sand; silty; clayey; some coarse grained; trace very coarse grained; some caliche; angular to subangular; moderately sorted; limestone sand; color: 2.5Y 6/3; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type: Surficial Soil, Grab
Site ID: 01-MPVU2 ~~01-MPVU-02~~ 9-3-93
Dia. of Hole: NA
Date/Time Started: 11/8/92, 1325
Date/Time Completed: 11/8/92
Surface Elevation:
Water Level: Initial (ft.): NA
Completion Depth ~~(ft.)~~ 4/6/93: 2 inches
Drilling Company: ~~Boyles Bros.~~ 4/6/93
No. Samples: 1
Drilling Method: Hand Dug
Driller: Ryan (?) O'Connell, Tooele Depot
Geologist/Date: R.J. Canon (Signature) 1/12/93
Checked by/Date: RTC 5/10/93

75 ft SW of IDF89

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained; so[illegible] medium grained; trace coarse to [illegible] coarse grained; much silt and clay; limestone sand; angular to sub-angular; color: 10YR 5/3; some caliche

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Sketch Map/Notes

Field Bore Log

01-MPVU3 ~~01 MPVU-3~~ [illegible] 9393

Site Type Surficial Soil, Grab Site ID ______ Dia. of Hole NA
Date/Time Started 11/8/92, 1447 Date/Time Completed 11/8/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ [illegible] 1/6/93 2 inches Drilling Company ~~Boyles Bros.~~ [illegible] 1/6/93 No. Samples 1
Drilling Method Hand dug Driller Mark Brooker
Geologist/Date R. T. Cannon (Signature) 1/12/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained sand; very clayey and silty; much medium grained sand, some coarse to very coarse grained sand; angular to subangular; color: 2.5 Y 5/3; limestone sand

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Sketch Map/No

Field Bore Log

Site Type Surficial Soil - Grab
Site ID ~~01-MPVU-4~~ 01-MPVU4 [initials] 9-3-93
Dia. of Hole NA
Date/Time Started 11/10/92, 1220
Date/Time Completed 11/10/92
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/16/93 2 inches
Drilling Company ~~Boyles Bros.~~ AW 4/16/93
No. Samples 1
Drilling Method Hand dug
Driller Roger (?) O'Connell
Geologist/Date R.T. Canon (Signature) 1/12/9~~2~~3 RTC 5/10/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med grained sa[nd]; some silt and clay; some coarse to very coarse sand; angular to subangular; moderately sorted; color: 10YR 5/2; trace to some caliche; limestone sand
5							
10							
15							

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(IDF-58 Mustard Barrels)

Field Bore Log

Sketch Map/Notes

01-MSD-58

Site Type	Surficial Soil, Grab	Site ID	Dia. of Hole NA
Date/Time Started	11/8/92, 1526	Date/Time Completed	11/8/92
Surface Elevation		Water Level: Initial (ft.)	NA
Completion Depth ~~(ft)~~ AW 4/6/93	2 inches	Drilling Company	~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method	Hand dug	Driller	Ryan (?) O'Connell, Tooele Depot
Geologist/Date	R. J. Canon (Signature) 1/12/9~~2~~3	Checked by/Date	

RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; silty to fine grained; clayey; some med. grained sand; angular to subangular; moderately sorted; Color: 10YR 5/4; limestone sand; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type Comp- Grab
Site ID 01-MSD-59 Dia. of Hole N/A
Date/Time Started 11/8/92 1615
Date/Time Completed 11/8/92 1615
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth (ft) 0-2"
Drilling Company Boyles Bros.
No. Samples 1
Drilling Method Hand Dug
Driller Tom Swanson
Geologist/Date Jon Coen (Signature) 1/12/93
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		10YR 4/4	v. fine to fine, slightly moist; subrounded to sub angular; mod sorted; minor pebble;

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Sketch Map/Notes

(Napalm area IDF-61)

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-NBA-61 Dia. of Hole NA

Date/Time Started ~~7/11/92~~ Nov. 7, 1420 Date/Time Completed ~~7/11/92~~ Nov. 7, 1992 RTC 1/12/93

Surface Elevation RTC 1/12/93 Water Level: Initial (ft.) NA

Completion Depth ~~(ft)~~ AWU 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AWU 4/6/93 No. Samples 1

Drilling Method Hand dug Driller Tom Swanson, Tooele Depot

Geologist/Date R. T. Canon (Signature) 1/12/93 Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to med. grained sand, some coarse to very coarse sand; some clay & silt; angular to subangular; moderately sorted; color: 5Y 3/1; looks incendarated.

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Sketch Map/Notes

Field Bore Log

-Grab 01-NEAS1 ~~01-NEAS-1~~ 9-3-93

Site Type Surficial Soil Site ID ______ Dia. of Hole NA
Date/Time Started 11/12/92 1520 Date/Time Completed 11/12/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller NA
Geologist/Date Travis Canon (Signature) 1/8/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained; moderately sorted; some silt and clay; angular to sub-angular; Color: 10YR 4/3; trace grey limestone very coarse grained sand; trace caliche
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

Site Type: Surficial Soil - Grab
Site ID: 01-PBA-~~92~~ 55 9-3-93
Dia. of Hole: NA
Date/Time Started: 11/12/92 1315
Date/Time Completed: 11/12/92
Surface Elevation:
Water Level: Initial (~~ft.~~): NA
Completion Depth (~~ft.~~): 2 inches
Drilling Company: ~~Boyles Bros.~~
No. Samples: 1
Drilling Method: Hand dug
Driller: ~~NA~~ NA
Geologist/Date: Travis Conon (Signature) 1/8/93
Checked by/Date:

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained; occassional med. to coarse grained material, trace to some clay and silt; subrounded to subangular; poorly to moderately sorted; color: 5YR 3/1 (very dark green to the eye); volcanic ash (?)
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

Site Type GRAB-Composite Site ID 01-PCA-74 Dia. of Hole N/A
Date/Time Started 11/7/92 1115 Date/Time Completed 11/7/92 1115
Surface Elevation Water Level: Initial (ft.) N/A
Completion Depth ~~(ft.)~~ AW 4/6/93 0-2" Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method HAND DUG Driller Ryan OConnell
Geologist/Date Jon Coen (Signature) 1/12/93 Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		#10YR 5/2	soft, subrounded to subangular; very fine to coarse sand; very small pebb' minor rootlets, minor clay, slightly moist

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Sketch Map/Notes

Field Bore Log

Site Type: GRAB - Composite
Site ID: 01-RA-88
Dia. of Hole: N/A
Date/Time Started: 7/11/92 1635
Date/Time Completed: 7/11/92 1635
Surface Elevation: N/A
Water Level: Initial (ft.): N/A
Completion Depth (~~ft.~~) 0-2" (4/6/93)
Drilling Company: ~~Boyles Bros.~~ (4/6/93)
No. Samples: 1
Drilling Method: HAND DUG
Driller: Ryan O'Connell
Geologist/Date: Jon Coen (Signature)
Checked by/Date:

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		10YR 4/2	Several Large Pebbles, minor clay, v. fine to med sands, minor cementing; Dark Grayish Brown, several roots.

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Sketch Map/Notes

Field Bore Log

Site Type Composite
Site ID 01-SEC1
Dia. of Hole 4"
Date/Time Started 11/11/92 1440
Date/Time Completed 11/11/92 1440
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth ~~(ft.)~~ AW 4/6/93 0-2"
Drilling Company ~~Boyles Bros.~~ AW 4/6/93
No. Samples 1
Drilling Method HAND DUG
Driller Ryan O'Connell
Geologist/Date Jon Coren (Signature) 1/12/92
Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		2.5Y 5/4	Light Olive Brown; v. Fine to medium sand; poor to mod sorted, dry, small rootlets, several minor Pebbles

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab | Site ID 01-SPDA-77 | Dia. of Hole NA

Date/Time Started 11/7/92 | Date/Time Completed 11/7/92

Surface Elevation | Water Level: Initial (ft.) NA

Completion Depth ~~(ft)~~ 2 inches | Drilling Company ~~Boyles Bros.~~ | No. Samples 1

Drilling Method Hand dug | Driller Ryan O'Connell

Geologist/Date R. T. Canon (Signature) | Checked by/Date

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to coarse grained; some very coarse grained sand; some silt and clay; angular to subangular; moderately sorted; look incendarated; color: 5Y 2.5/1 (very dark blackish green))

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Sketch Map/Notes

(IDF 99)

Field Bore Log

Site Type surficial Soil, Grab   Site ID 01-SPDA-99   Dia. of Hole NA
Date/Time Started 11/9/92, 1245   Date/Time Completed 11/9/92
Surface Elevation ______   Water Level: Initial (ft.) NA
Completion Depth ~~(ft)~~ AW 4/6/93 2 inches   Drilling Company ~~Boyles Bros.~~ AW 4/6/93   No. Samples 1
Drilling Method Hand dug   Driller Tom Swanson, Tooele Depot
Geologist/Date R. T. Canon (Signature) 1/12/93   Checked by/Date ______
RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med. grained sand silty and with clay chips; some coarse to very coarse grained sand; angular to subangular; moderately sorted; Color: 5Y 3/2 (very dark green)

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil, Grab Site ID 01-TA-301 ~~01-TA-30~~ Dia. of Hole NA
Date/Time Started 11/11/92, 0825 Date/Time Completed 11/11/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ 2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1
Drilling Method Hand Dug Driller Ryan O'Connell
Geologist/Date R. J. Canon Checked by/Date ______
(Signature) 1/12/93 RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained sand; silty; clayey; angular to subangular; some med. to coarse sand; moderately sorted; color: 2.5Y 6/3; limestone sand; some caliche

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Sketch Map/Notes

Field Bore Log

Site Type ~~#~~ 9C GRAB
Site ID ~~01-TA-302~~ 01-TA-302 MAT 9-3-93
Dia. of Hole N/A
Date/Time Started 11/11/92
Date/Time Completed 11/11/92
Surface Elevation N/A
Water Level: Initial (ft.) N/A
Completion Depth ~~(ft)~~ AW 4/6/93 0-2"
Drilling Company ~~Boyles Bros.~~
No. Samples 1
Drilling Method HAND DUG
Driller Tom Swanson
Geologist/Date Jon Coen 1/12/93 (Signature)
Checked by/Date
RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2"	0-2"		10YR 5/4	v Fine to medium sand, subrounded to subangular; minor organic debris mixed in w/ sand; Yellowish Brown; moderate sorted

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil-Grab Site ID 25-NWAS Dia. of Hole NA
Date/Time Started 11/14/92 Date/Time Completed 11/14/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller NA
Geologist/Date Travis Conon (Signature) 1/8/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained, some med grained; silty; some clay; moderately sorted; sand appears to be grey limestone; angular to sub-angular Color: 10YR 5/3 ; trace limestone granules; trace caliche
5							
10							
15							

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Sketch Map/Note

Field Bore Log

Site Type Composite Surface Sample Location **Site ID** 25-DDC-92 **Dia. of Hole** NA

Date/Time Started 02/08/93 @ 1048 **Date/Time Completed** 02/08/93 @ ~~1200~~ 1111 DEO 02/08/93

Surface Elevation ______ **Water Level: Initial (ft.)** NA

Completion Depth (ft.) 2 inches **Drilling Company** ~~Boyles Bros.~~ UYB/AGEISS 02/08/93 **No. Samples** 1

Drilling Method Surficial sample - Stainless Steel Shovel **Driller** D. Hanley

Geologist/Date D.C. DeLeon / 02/08/93 (Signature) **Checked by/Date** Alan Warner 4/4/93

Depth (ft.) (inch) DEO 02/08/93	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–2	NA	Composite G1631 + RINSE BLANK	0-2	inches	NA	SM DEO 02/08/93	0-2 inches = Silty f-vc sand w/ ~~some silt~~ and trace gr DEO 02/08/93 (f-vc sand = 67%, gravel = 5%, silt = 28%). 2.5Y 5/2 - Grayish Brown. Not plastic. Not cemented. ~~Consistency unknown~~ Consistency unknown - see below. Wet - due to snow or rain. Sand + gravels are angular.

T.D. = 2 inches.
No Water Encountered.

Note
Consistency could not be determined as first 2 inches of ground frozen solid.

Rev. 11/9/92 NA = Not applicable. T.D. = Total Depth.

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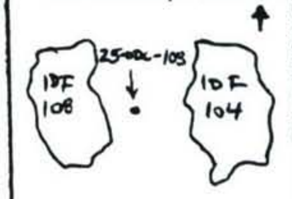
Sketch Map/Notes N



Field Bore Log

Site Type Trench
Site ID 25-ODC-108 Dia. of Hole NA
Date/Time Started 02-08-93 @ 1415
Date/Time Completed 02-08-93 @ 1715
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (ft.) 10 ft.
Drilling Company ~~Boyles Bros.~~ UXB DEO 02-08-93
No. Samples 3
Drilling Method Backhoe
Driller (Operator) - Kieth Schucker
Geologist/Date [signature] /02-08-93 (Signature)
Checked by/Date A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0	DEO 02-08-93 NA	Grab composite G1632	0-2 inches		NA	SM	0-2 inches = Silty f sand w/ some m-c sand + trace gravel. (Gravels up to ~1/2" long.) 35% silt, 40% sand, 20% m-c sand, and 5% gravel. 10YR 5/3 - Brown. Not plastic, very dense - possibly due to frost, not cemented. Wet - probably due to snow @ ground surface.
1, 2, 3							- Frost extends to 3 ft. depth
4	NA	Grab G1633	4-5 ft.		NA	ML	- Operator notes that material is finer w/ depth. - Color appears to lighten w/ depth.
5, 6, 7, 8							4-5 feet = F sandy silt w/ clay + trace m-c Sand. (15% clay, 55% silt, 25% f sand, 5% m-c sand). 10YR 5/4 Yel. Brown. Low plasticity, noncemented, very ~~dense~~ hard based on operator observations. Moist - could be due to snow/rain. DEO 02-08-93
9	NA	Grab G1634	9-10 ft.		NA	ML	Softening slightly w/ depth.
10							9-10 feet = Fine sandy silt w/ clay. (clay = 20%, silt = 50%, fine sand = 30%.) 10YR 5/4 Yell. Brown. Low plasticity. Not cemented, ~~dense~~ hard to very ~~dense~~ hard - less hard than overlying material, moist - may be due to snow/rain. DEO 020893 DEO 02-08-93
15							Overall, digging was very hard, as per backhoe operator.
							T.D. = 10 ft. No Water Encountered.

Rev. 11/9/92 NA - Not Applicable. T.D. = Total Depth ft. = feet

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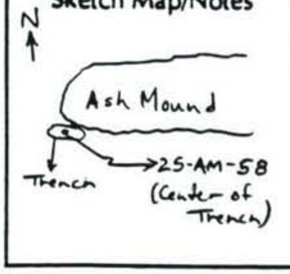
Sketch Map/Notes



Field Bore Log

Site Type: Trench (Grab Samples) Site ID: 25-AM-58 Dia. of Hole: NA

Date/Time Started: 11-18-92 @ 1100 Date/Time Completed: 11-18-92 @ ~~1420~~ 1338 DKP 11-18-92

Surface Elevation: Water Level: Initial (ft.) NA

Completion Depth (ft.): 10 ft. Drilling Company: ~~Boyles Bros.~~ UXB International DKP 11-18-92 No. Samples: 2

Drilling Method: Trenching w/ Backhoe Driller: Keith Schucker

Geologist/Date: Diane E. DePersis (Signature) / 11-18-92 Checked by/Date: Alan Warner 4/6/93

Note: Samples collected from the center of 8 ft. long trench.

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–4							~~0-5 ft.~~ DKP 11-18-92 0-0.5 ft. = Grey ash with some rusted metal debris. Native material starts at 0.5 ft. below ground surface. Operator notes that digging in hard from 0.5 ft.
4–5	NA	Grab 4-5 ft.	4-5 ft.	4-5 ft.	NA	ML	4-5 ft. = Clayey SILT w/ trace sand and trace gravel. (clay = 28%, silt = 65%, sand = 5%, gravel = 2%). Low plasticity, Hard, Not cemented, medium moisture. Lt. yel. brown (2.5Y 6/3). SAMPLE TAG NO. G1552
6–9							Operator notes digging in very hard (harder than above) from 6-10 ft.
9–10	NA	Grab 9-10 ft.	9-10 ft.	9-10 ft.	NA	ML	9-10 ft. = Clayey SILT w/ trace sand and gravel. Slightly clayier than previous sample (4-5 ft.) (33% clay, 60% silt, 5% sand, 2% gravel). Low to Med. Plastic. Hard to Very Hard, Not cemented. Little moisture. Brown (10YR 5/3). SAMPLE TAG NO. G1553
10–15							Total Depth = 10 ft. No Water Encountered.

Rev. 11/9/92 NA = Not Applicable W/ = with @ = at ft. = feet
No. = Number

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Sketch Map/No

Field Bore Log

Site Type Surficial Soil, Grab — Site ID 25-CT-07 — Dia. of Hole NA

Date/Time Started 11/14/92 — Date/Time Completed 11/14/92

Surface Elevation ______ — Water Level: Initial (ft) NA

Completion Depth ~~(ft)~~ RTC 11/12/93 2 inches — Drilling Company ~~Boyles Bros.~~ — No. Samples 1

Drilling Method Hand Dug — Driller ?

Geologist/Date R. G. Canon (Signature) — Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine grained sand; much clay and silt; much caliche; trace coarse grained sand to granules; angular to sub-angular sand; moderately sorted; color: 10YR 6/2; limestone sand
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

Site Type: Surficial Soil - Grab
Site ID: 25-CT-08
Dia. of Hole: NA
Date/Time Started: ?
Date/Time Completed: ?
Surface Elevation:
Water Level: Initial (ft.): NA
Completion Depth ~~(ft.)~~ AW 4/6/93: 2 inches
Drilling Company: ~~Boyles Bros.~~ AW 4/6/93
No. Samples: 1
Drilling Method: Hand dug
Driller: NA
Geologist/Date: Travis Canon (Signature) 1/8/93
Checked by/Date:

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; fine-med. grained; angular to subangular; some clay; numerous grey limestone ~~p~~ chips, angular with caliche coatings; moderately sorted; Color: 10YR 6/1; sand is grey limestone
5							
10							
15							

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Sketch Map/Notes

(IDF 59 Incendiary Burn Area)

Field Bore Log

Site Type Surficial Soil - Grab Site ID 25-IBA-59 Dia. of Hole NA

Date/Time Started 11/6/92 1500 Date/Time Completed 11/6/92

Surface Elevation ____ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 9/6/92 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand dug Driller NA

Geologist/Date Travis Canon (Signature) 1/8/93 Checked by/Date ____

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; fine to coarse grained; s[illegible] silt and very fine grained sand; trace clay and very coarse grained sand and granules; poorly sorted; angular to subrounded; color: 2.5Y 2.5/1
5							
10							
15							

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Sketch Map/Notes

N ↑

25-104-59

~~[illegible]~~ S-100-92

approx 200 ft west of S-100-92

Field Bore Log

Site Type: Bore
Site ID: 25-IBA-59
Dia. of Hole: 7 inch
Date/Time Started: 12-14-92 / 1120
Date/Time Completed: 12-14-92 / 1205
Surface Elevation:
Water Level: Initial (ft.): NA
Completion Depth (ft.): 10.0 Ft
Drilling Company: Boyles Bros.
No. Samples: 2
Drilling Method: HSA
Driller: J. Hulse
Geologist/Date: [signature] (Signature)
Checked by/Date: A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0							
5		split spoon 1	4.0-5.0	4.0-5.0	1.0/1.0	ML	4-5 ft clayey SILT, 70% silt, 30% clay; 10YR 6/6 brownish yellow; low plasticity; med. consistency; dry; some caliche occurring in ~~[illegible]~~ lenses < [illegible]" thick
10		split spoon 2	9.0-10.0	9.0-10.0	1.0/1.0	ML	9-10 ft clayey SILT; same as above in 4-5 ft. with caliche-rich zone at approx 9.2-9.4 ft
							TD = 10.0 Ft
15							

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Sketch Map/Not

(IDF-60 Burn Area)

Field Bore Log

Site Type ~~Surficial~~ Grab Soil
Site ID 25-IBA-60
Dia. of Hole NA
Date/Time Started 11/14/92
Date/Time Completed 11/14/92
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches
Drilling Company ~~Boyles Bros.~~ AW 4/6/93
No. Samples 1
Drilling Method Hand dug
Driller NA
Geologist/Date Travis Canon (Signature) 1/8/9~~2~~3
Checked by/Date
RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to ~~moderate~~ m RTC 1/8/93 grained sand; some clay, silt, ; trace to some granules to coarse grained sand; poorly sorted; angular to subangular; color: 5Y 5/1; trace visible caliche
5							
10							
15							

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(IDF65 Incendiary Burn Area)

Field Bore Log

Sketch Map/Notes

Site Type Surficial Soil - Grab Site ID 25-IBA-65 Dia. of Hole NA
Date/Time Started 11/6/92 1533 Date/Time Completed 11/6/92
Surface Elevation Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller NA
Geologist/Date Travis Canon 1/8/93 Checked by/Date
(Signature)

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to med grained sand, some coarse to very coarse grained sand; rare clay and granules; poorly - moderately sorted; angular to subangular; color: 2.5Y 4/1
5							
10							
15							

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Sketch Map/Notes

N

S-100-92 25-IBA-65

~200 ft

25-IBA-65 located approx 200 ft East of S-100-92

Field Bore Log

Site Type Bore
Site ID 25-IBA-65 Dia. of Hole 7 inch
Date/Time Started 12-14-92 / 1235
Date/Time Completed 12-14-92 / 1245
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (ft.) 5.0
Drilling Company Boyles Bros.
No. Samples 1
Drilling Method Hollow Stem Auger
Driller J. Hulse
Geologist/Date [signature] (Signature)
Checked by/Date A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0							
1							
2							
3							
4		split spoon	4-5 feet	4-5 ft	1.0/1.0	ML	4-5 ft: clayey SILT; 60% silt, 40% clay; 10YR 5/4 yellowish brown; low plasticity; med. consistency; dry note Trace gravel at 4.8-5.0 ft TD=5.0 ft
5							

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(IDF 67 Incendary Disposal Area)

Field Bore Log

Sketch Map/Notes

Site Type Surficial Soil - Grab Site ID 25-IBA-67 Dia. of Hole NA
Date/Time Started 11/6/92, 1630 Date/Time Completed 11/6/92
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1
Drilling Method Hand dug Driller E. Kirby (Tooele Depot)
Geologist/Date R. J. Canon (Signature) 1/12/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to fine grained; some med-coarse grained sand ~~,~~ ~~w/~~ RTC 1/12/93 with lesser amounts of very coarse grained sand; ~~and~~ RTC 1/12/93 numerous granules to small pebbles, all angular; sand angular to sub-angular; moderately to poorly sorted; trace clay to silt; Color: 2.5Y 2.5/1 (a very dark green)
5							
10							
15							

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Sketch Map/No

Field Bore Log

Site Type Surficial Soil-Grab Site ID 25-IDC-10 Dia. of Hole NA

Date/Time Started 11/14/92 Date/Time Completed 11/14/92

Surface Elevation ______ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ AW 4/6/93 2 inches Drilling Company ~~Boyles Bros.~~ AW 4/6/93 No. Samples 1

Drilling Method Hand dug Driller NA

Geologist/Date Travis Conon (Signature) 1/8/93 Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; ~~some~~ much clay and silt; sub-a to subrounded; very fine to fine grained sand; caliche coatings on some sand grains; color: 10YR 6/2; poorly sorted; sand appears to be grey limestone

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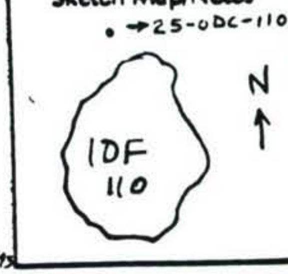
Sketch Map/Notes



Field Bore Log

Site Type: Trench
Site ID: 25-ODC-110
Dia. of Hole: NA
Date/Time Started: 02-09-93/ 1105
Date/Time Completed: ~~02-09-93~~ 02-10-93/ ~~1128~~ 1019 am
Surface Elevation:
Water Level: Initial (ft.): NA
Completion Depth (ft.): 10 ft.
Drilling Company: ~~Boyles Bros.~~ UXB
No. Samples: 3
Drilling Method: Backhoe
Driller: Keith Schucker
Geologist/Date: [signature] /02-09-93 (Signature)
Checked by/Date: A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0	NA	Composite G1635	0-2	inches	NA	SM	0-2 inches = Silty f-vc sand w/ trace gravel. (silt = 26%, fine sand to med. sand = 20%, coarse to vc sand = 50%, gravel = 4%). 10YR 5/3 - Brown. Not plastic. Very dense. Not cemented, wet - probably due to snow + rain @ ground surface
1–3							Relatively harder than other trenching locations. operator notes harder digging after 1 ft.
4	NA	Grab G1636	4-	5 ft.	NA	SC	~~4-5 ft.~~ 4-5 ft. = F to vc sand w/ trace clay and trace gravel. (15% clay, 25% f-m sand, 45% c-vc sand, 15% gravel.) 10YR 5/4 - Yel. Brn. Not cemented. Moist. Very low plasticity.
5–8							Digging is much easier starting @ ~8 ft. below ground surface.
9	NA	Grab G1637	9-	10 ft	NA	SC	9-10 ft. = F to vc sand w/ trace clay + trace gravel. (15% clay, f-m sand = 35%, c-vc sand = 45%, gravel = 5%). 10YR 5/4 Yell. Brown, Not cemented, moist, Very low plasticity.
10–15							T.D. = 10 ft. No water encountered.

These 2 sample descriptions completed w/ the assistance of E Kiely.

Rev. 11/9/92 NA - Not Applicable. ft. = feet TD = Total Depth @ = at
F - Fine VC - Very Coarse C - coarse m - medium

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Sketch Map/Note: IDF 119; 25-ODC-119

Field Bore Log

Site Type: ~~Y~~ Composite Surface Sample Location (AEA 02/08/93)
Site ID: 25-ODC-119
Dia. of Hole: NA
Date/Time Started: 02/08/93 @ 1131
Date/Time Completed: 02/08/93 @ 1200
Surface Elevation:
Water Level: Initial (ft.) NA
Completion Depth (ft.): 2 inches
Drilling Company: ~~Boyles Bros.~~ UXB/AGEISS (AEA 02/08/93)
No. Samples: 1
Drilling Method: Surficial sample - Stainless steel shovel
Driller: D. Hanley
Geologist/Date: D. F. DePersia/02/08/93 (Signature)
Checked by/Date: A. Warner 4/14/93

Depth ~~(ft)~~ (inches)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–2	NA	Composite G163B	0-2 inches		NA	SM	0-2 inches = f-vc sand w/ some silt and trace gra... (f-vc sand = 70% (mostly c-vc), gravel = 10%, silt = 20%). 2.5Y 6/2 - Light brownish gray. Not plastic. Not [illegible]d. Consistency unknown - see below. Wet - due to snow or rain. (Gravels are angular - up to 3/4 inch long)

T.D. = 2 inches.
No Water Encountered.

Note
Consistency could not be determined as first 2 inches of ground frozen solid.

Rev. 11/9/92 NA - Not Applicable. T.D. = Total Depth

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Sketch Map/Notes

Field Bore Log

Site Type Surficial Soil - Grab

Site ID ~~25-UA~~ 25-UA1 9-3-93 Dia. of Hole NA

Date/Time Started 11/14/92 Date/Time Completed 11/14/92

Surface Elevation ____ Water Level: Initial (ft.) NA

Completion Depth ~~(ft.)~~ 2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1

Drilling Method Hand dug Driller NA

Geologist/Date Travis Canon (Signature) 1/8/93 Checked by/Date ____

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			Sand; very fine to fine grained; ~~some to~~ much silt + clay; occossional granule and coarse grained sand; angular to sub-rounded; poorly sorted; color: 10YR 5/3; sand appears to be grey limestone

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Sketch Map/Note

Field Bore Log

Site Type Surficial Soil - Grab   Site ID 25-UA2   Dia. of Hole NA

Date/Time Started 11/14/92   Date/Time Completed 11/14/92

Surface Elevation ______   Water Level: Initial ~~(ft.)~~ NA

Completion Depth ~~(ft.)~~ PAW 4/6/93 2 inches   Drilling Company ~~Boyles Bros.~~ AW 4/6/93   No. Samples 1

Drilling Method Hand dug   Driller NA

Geologist/Date Travis Canon (Signature) 1/8/93   Checked by/Date ______

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; very fine to fine grained some med. grained; some clay and silt; angular to sub-rounded; poorly to moderately sorted; trace very coarse grained sand; color: 10YR 6/2; trace caliche; limestone sand
5							
10							
15							

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Sketch Map/Notes

Field Bore Log

(East of IDF 7)

Site Type Surficial Soil, Grab Site ID ~~25-UA-3~~ 25-UA3 9-3-93 Dia. of Hole NA

Date/Time Started 11/14/92 Date/Time Completed 11/14/92

Surface Elevation ____ Water Level: Initial (ft.) NA

Completion Depth ~~(ft)~~ 2 inches Drilling Company ~~Boyles Bros.~~ No. Samples 1

Drilling Method Hand dug Driller ?

Geologist/Date A. T. Cavon (Signature) 1/12/93 Checked by/Date RTC 5/10/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0			0-2 inches	0-2 inches			sand; clayey silty sand; very fine to fine sand; moderately to well sorted; subangular to subrounded; color: 2.5Y 6/2 ; some caliche

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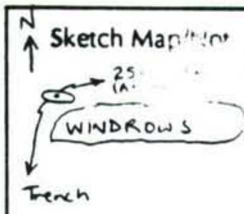
Sketch Map/Notes



Field Bore Log

Site Type Trench (Grab Samples) Site ID 25-WIND Dia. of Hole NA
Date/Time Started 11-18-92 @ 1520 Date/Time Completed 11-18-92 @ 1620
Surface Elevation ______ Water Level: Initial (ft.) NA
Completion Depth (ft.) 10 ft. Drilling Company ~~Boyles Bros.~~ UXB International 11-18-92 No. Samples 2
Drilling Method Trenching w/ Backhoe Driller Keith Schucker
Geologist/Date D.E. DeLoris/11-18-92 (Signature) Checked by/Date A. Warner 4/4/93

Note: Samples collected from the center of 8 ft. long trench.

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–3							0-1 ft. = Metallic debris from Wind. Native material presumably starts at 1 ft. (approximate). Operator notes extremely hard digging after 1 ft.
4–5	NA	Grab 4-5 ft.	4-5 ft.	4-5 ft.	NA	ML	4-5 ft. = Clayey SILT. (30% clay, 70% silt). Low plasticity, Very Hard, Not cemented, Med. moisture. Lt. Yel. Brown (2.5Y 6/4). SAMPLE TAG NO. G1554. Extremely hard digging continues from 6 to 10 ft.
9–10	NA	Grab 9-10 ft.	9-10 ft.	9-10 ft.	NA	ML	9-10 ft. = Clayey SILT. (38% clay, 62% silt). Clayier than above sample (4-5 ft.). Low to Med. plasticity, very Hard, Not cemented, Little moisture. Lt. Yel. Brown (2.5Y 6/4). SAMPLE TAG NO. G1555
							Total Depth = 10 ft. No Water Encountered.

Rev. 11/9/92 NA = Not Applicable No. = Number w/ = with @ = at ft = feet

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Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Notes

Field Bore Log

Site Type: TRENCH AW 4/4/93
Site ID: ~~S-35-37-04~~ 37-BF1 9-3-93
Dia. of Hole: NA
Date/Time Started: 02/~~09~~10/93 - 1238
Date/Time Completed: 02/~~09~~10/93 ~~1530~~ 1395 AW 4/4/93
Surface Elevation:
Water Level: Initial (ft.): NA
Completion Depth (ft.): 3 FT
Drilling Company: ~~Boyles Bros.~~ UXB 2-4-93
No. Samples: 3
Drilling Method: BACKHOE
Driller: KEITH SCHUCKLER
Geologist/Date: (Signature)
Checked by/Date: A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0	NA	GRAB 61640	0-2 INCHES		NA	SM	0-2 INCHES = ~~SILTY~~ GRAVELLY F-VC SAND WITH ~~GRAVEL~~ SILT. 2-10-93 SILT = 20%, FINE TO MED SAND = 20%, COARSE SAND GRAVEL = 35% 10YR 5/3 - BROWN. NOT PLASTIC, DENSE, NOT CEMENTED, WET - SNOWMELT. SOIL APPEARS TO HAVE BEEN BACKFILLED - DIFFERENT FROM SURROUNDINGS. EXCAVATION WAS EASY, GROUND IS SOFT.
5	NA	GRAB 61641	6-12 INCHES		NA	SP	6-12 INCHES = GRAVELLY SAND F-VC SAND ~~WITH GRAVEL~~ 2-10-93 SILT = 10%, FINE TO MED SAND = 20%, COARSE SAND 40% GRAVEL 40% 10YR 5/3 - BROWN, NOT PLASTIC, DENSE NOT CEMENTED, MOIST, GAP GRADED. SOIL APPEARS TO HAVE BEEN BACKFILLED FROM ANOTHER AREA; GROUND WAS SOFT AND EASY TO EXCAVATE.
10	NA	GRAB 61642	24"-36"		NA	SP	24-36 INCHES GRAVELLY SAND F-VC SAND ~~WITH GRAVEL~~ 2-10-93. SILT 0%, FINE TO MED SAND 15%, COARSE SAND 40% GRAVEL 45% 10YR 5/3 - BROWN, NOT PLASTIC, DENSE NOT CEMENTED, MOIST, GAP GRADED. SOIL APPEARS TO HAVE BEEN BACKFILLED FROM ANOTHER AREA, GROUND WAS SOFT AND EASY TO EXCAVATE.
15							

WW 2-10-93

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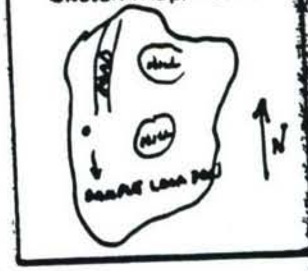
Sketch Map/Notes



Field Bore Log

Site Type TRENCH
Site ID ~~?-37-05~~ 37-BF2 9-3-93
Dia. of Hole NA
Date/Time Started 02/10/93 - 1315
Date/Time Completed 2/10/93 - 1338
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (ft.) 3FT
Drilling Company UXB ~~Boyles Bros.~~ EK 2-10-93
No. Samples 3
Drilling Method BACK HOE
Driller KEITH SCHUCKER
Geologist/Date (Signature)
Checked by/Date A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0	NA	GRAB 61643	0-2 INCHES		NA	SC	0-2 INCHES = GRAVELY ~~CLAYEY~~ SAND VF-VC SAND W/ ~~?~~ EK 2-10-93. FINE TO MED SAND = 25%, COARSE TO V. COARS SAND 35%, CLAY 10%, GRAVEL 30%. 10YR 5/3 BROWN, LOW PLASTICITY, NOT CEMENTED, WET
5	NA	GRAB 61644	6-12"		NA	SW ~~SM~~ EK 2-10-93	6-12 INCHES = GRAVELLY SAND f-VC SAND ~~w/ GRAVEL~~ EK 2-10-93. FINE TO MED SAND 30%, COARSE SAND 45%, GRAVEL 25%. 10YR 5/3 BROWN, NOT PLASTIC, DENSE, NOT CEMENTED, MOIST, WELL GRADED. SOIL APPEARS TO HAVE BEEN BACKFILLED FROM ANOTHER LOCATION
10	NA	GRAB 61645	24-36"		NA	~~SM~~ SW EK 2-10-93	24-36 INCHES = GRAVELLY SAND f-VC SAND ~~w/ GRAVEL~~ EK 2-10-93. FINE TO MED SAND 25%, COARSE SAND 50%, GRAVEL 25%. 10YR 5/4 BROWN, NOT PLAST. DENSE, NOT CEMENTED, MOIST, WELL GRADED. SOIL APPEARS TO HAVE BEEN BACKFILLED FROM ANOTHER LOCATION. SOME "SLAG" MATERIAL MIXED IN.
15							

EK 2-10-93

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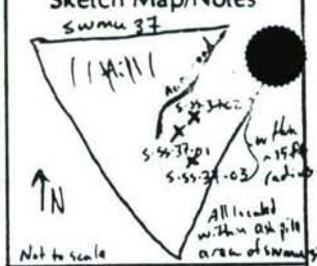
Sketch Map/Notes



Field Bore Log

Site Type Bore

Site ID ~~S-SS-37-01~~ 37-SP1 9-3-93 Dia. of Hole 7 inches

Date/Time Started 12-14-92 / 1405

Date/Time Completed 12-14-92 / 1430

Surface Elevation

Water Level: Initial (ft.) NA

Completion Depth (ft.) 3.0

Drilling Company Boyles Bros.

No. Samples 3

Drilling Method Hollow Stem Auger

Driller J. Hulse

Geologist/Date [signature] (Signature)

Checked by/Date A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0		grab	0-2 inches			GM	0-3 ft: silty GRAVEL with some clay; 65% gravel 10% clay; fines 10YR 6/4 light yellowish brown gravels sub-angular; loose; dry.
		split spoon	6-12 inches				
1							
2		split spoon	24-36 inches				
3							TD = 3.0 ft

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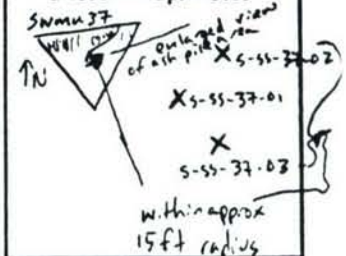
Sketch Map/Notes



Field Bore Log

Site Type: Bore
Site ID: ~~S-SS-37-02~~ 37-SP2 9-3-93
Dia. of Hole: 7 inches
Date/Time Started: 12-14-92/1450
Date/Time Completed: 12-14-92/1515
Surface Elevation:
Water Level: Initial (ft.) NA
Completion Depth (ft.): 3.0
Drilling Company: Boyles Bros.
No. Samples: 3
Drilling Method: Hollow Stem Auger
Driller: J. Hulse
Geologist/Date: [signature] (Signature)
Checked by/Date: A. Warner 4/14/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0		grab	0-2 inches			GM	0-3 ft: silty GRAVEL with some clay; 65% gravel, 25% silt, 10% clay; fines 10YR 6/4 light yellowish brown; gravels sub-angular; loose; dry.
		split spoon	6-12 inches				
1							
2		split spoon	24-36 inches				
3							TD = 3.0 ft

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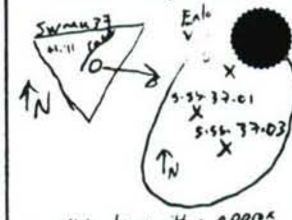
Sketch Map/Notes



Note: All locations within approx 15 ft radius in ash-pile area of SWMU 37

Field Bore Log

37-SP3 9-3-93

Site Type Bore
Site ID ~~S-SS-37-03~~
Dia. of Hole 7 inches
Date/Time Started 12-14-92 / 1410
Date/Time Completed 12-14-92 / 1615
Surface Elevation
Water Level: Initial (ft.) NA
Completion Depth (ft.) 3.0
Drilling Company Boyles Bros.
No. Samples 3
Drilling Method Hollow Stem Auger
Driller J. Hulse
Geologist/Date [signature] (Signature)
Checked by/Date A. Warner 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0		grab	0-2 inches			GM	0-3 ft: silty GRAVEL with some clay; 65% gravel 25% silt, 10% clay; fines 10YR 6/4 light yellow brown; gravels sub-angular; loose; dry.
		split spoon	6-12 inches				
1							
2		split spoon	24-36 inches				
3							TD = 3.0 ft

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S-93-92

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Sketch Map/Not

Field Bore Log

Site Type: Test Boring
Site ID: S-93-92 Test Hole
Dia. of Hole: 8.0" OD
Date/Time Started: 11-12-92 / 1401
Date/Time Completed: 12-4-92/1540
Surface Elevation:
Water Level: Initial (ft.) 145 ft (confined)
Completion Depth (ft.) 150.0
Drilling Company: Boyles Bros.
No. Samples: 32
Drilling Method: HSA 3"4" ID
Driller: Jay Hulse
Geologist/Date: [signature] /12-4-92 (Signature)
Checked by/Date: A. Warner 4/6/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0				Cuttings 4.0	NA	CH	0.0'-4.0' Silty CLAY w/ some v. fine to fine sand, trace of pebbles. 30% Silt, 50% Clay, 15% Sand, 5% Pebbles. 5Y 6/1 Gray, Med. plasticity, med. consis., MD, Dry
5		Geotech. SS	2.0	Composite	2.0/2.0	CL	4.0'-6.0' Silty CLAY w/ some v. fine to fine sand. 30% Silt, 50% Clay, 20% Sand. 5Y 7/1 Light Gray. Low plasticity, med. consis., L, Dry. Some localized caliche, traces of brown organic zones scattered throughout.
10		Geotech. SS	2.0	Composite	1.7/2.0	CL	9.0'-11.0' Silty CLAY w/ trace v. fine to fine sand. 25% Silt, 65% Clay, 10% Sand. 5Y 6/2 Light Olive Gray. Low plasticity, MST, MD to D, Dry. Occasional caliche nodules
15		Geotech. SS	1.2	Composite	1.2/1.2	SC	14.0'-15.2' Med. to fine, v. fine SAND w/ some clay, trace of silt. 70% Sand, 20% Clay, 10% Silt. Low to non-plasticity, M to SO, L, Dry. 10YR 6/3 Pale Brown.
			.8		.8/.8	CL	15.2'-16.0' Silty CLAY w/ trace v. fine to fine sand. Same as 9.0'-11.0' interval.

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8-93-92

Field Bore Log

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
20		4 split spoon	19.0 - 21.0 ft	19.0 - 21.0 ft	2.0/2.0 ft	CL	19-21 silty CLAY 75% clay, 25% silt; 10YR 7/2 light gray; med plasticity; stiff to very stiff, Dry. Trace v. thin iron veins
		cuttings					Fining with depth, no major discontinuities noted, dry
25		5 split spoon	24-26 ft	24-26 ft	2.0/2.0 ft	ML	24-26 clayey SILT with trace v. fine grained sand; 60% silt 35% clay 5% v. fine sand; 5Y 7/2 light gray; ~~[illegible]~~ 11-30-92 low plasticity, stiff, dry
		cuttings					no major discontinuities noted, dry
30		6 split spoon	29.0 - 29.7 ft	29.0 - 29.7 ft	0.7/0.7 ft	ML	29.0 - 29.7 ft ~~[illegible]~~ SILT with some clay and some sand, 60% silt, 20% v. fine grained sand, 20% clay; 5Y 8/1 white; no to low plasticity, v. stiff to hard (Auger 0.7 ft to refusal) dry
		cuttings					no major discontinuities noted, dry
35		7 split spoon	34.0 35.5	34.0 - 35.5	1.5/1.5	ML	34-35.5 ft Sandy SILT, ~~[illegible]~~ 75% silt, ~~[illegible]~~ 25% v. fine grained sand; 5Y 7/2 light gray; non-plastic; stiff; dry
		cuttings					no major discontinuities noted, dry
40		8 split spoon	39.0 - 41.0	39.0 - 41.0	2.0/2.0	ML	39 - 41 ft ~~[illegible]~~ SILT with some clay and some sand, 60% silt, 20% v. fine sand 20% clay; 5Y 8/2 pale yellow; low plasticity; stiff, dry
		cuttings					no major discontinuities noted, dry
45		9 split spoon	44-46	44-46	2.0/2.0	CL	44-46 silty CLAY. 60% clay, 40% silt; 5Y 8/2 pale yellow; med plasticity; stiff; low moisture
		cuttings					moist, clay-rich cuttings noted (same as above)
50		10 split spoon	49-50.5	49-50.5	2.0/2.0	CL	49-51 silty CLAY, 65% clay, 35% silt, 5Y 8/2 pale yellow, med plasticity; med stiff, med. moisture to moist (moist in upper 0.4 ft grading to med. moist below)

11-30-92
12-1.92

12-1.92

Field Bore Log Test Hole

Begin 51
12-2-92

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
		cuttings					moist, no major discontinuities
55		11 split spoon	54-56 ft	54-56 ft	2.0/2.0	CL	54-56 ft silty CLAY; 60% clay, 40% silt; 5Y 8/2 pale yellow; low to med plasticity; stiff, low moisture, note a minor (<0.2 ft) brownish silt rich layer at 54.5 ft with med moisture
		cuttings					moist, no major discontinuities
60		12 split spoon	59-61 ft	59-61 ft	2.0/2.0	CL	59-61 silty CLAY; 70% clay, 30% silt, 5Y 8/2 pale yellow; med plasticity; firm; med. moist
		cuttings					moist, no major discontinuities
65		13 split spoon	64-66	64-66	2.0/2.0	CL	64-66 silty CLAY, 65% clay, 35% silt, 5Y 8/2 pale yellow, med plasticity, stiff, med. moist
		cuttings					moist, no major discontinuities; slight coarsening
		14 split spoon	69.0-69.75	69.0-69.75	0.75/0.75	ML	69.0-69.75 ft clayey SILT; 65% silt, 35% clay; 5Y 8/2 pale yellow; low to med plasticity, v. stiff, ~~low~~ med moisture
70		cuttings					moist, no major discontinuities
75		15 split spoon	74-76 ft	74-76 ft	2.0/2.0	ML	74-76 ft: clayey SILT, 60% silt, 40% clay; 5Y 8/2 pale yellow; low to med plasticity; v. stiff, med. moisture. thin organic layer noted at 75.9 ft to wet at bottom
		16 split spoon	76-78 ft	76-78	2.0/2.0	ML	76-78 ft: clayey SILT, 55% silt, 45% clay, 5Y 8/2 pale yellow, low to med. plasticity; v. stiff, med. moist. gradational w/ above, slight increase in clay %
		cuttings					moist, no discontinuities
80		17 split spoon	79-81	79-81	2.0/2.0	ML	79-81: clayey SILT, 70% silt, 30% clay; 5Y 7/1 light gray, low plasticity; hard; med. moist
		cuttings					moist, no major discontinuities; slight fining and goes from light gray to greenish gray

Field Bore Log

Test Hole

83

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
		cuttings					see above
85		18 split spoon	84-86	84-86	2.0/2.0	CL	84-86ft silty CLAY; 60% clay, 40% silt; 5GY 6/1 greenish gray; low to med plasticity; v. stiff; low moisture
		cuttings					moist cuttings, no major discontinuities; slight coarsening
90		19 split spoon	89-91	89-91	2.0/2.0	ML	89-91ft: clayey SILT ~~70%~~ 60% silt, ~~30%~~ 40% clay; 5GY 6/1 greenish gray; low to med plasticity; ~~stiff~~ 12-2-92 hard; mod. moist to moist note that core barrel was wet
		cuttings					moist cuttings, no major discontinuities
95		20 split spoon	94-96	94-96	2.0/2.0	ML	94-96ft: clayey SILT; 70% silt, 30% clay; 5GY 7/1, light greenish gray; low plasticity, hard (packed core); moist Note that barrel was wet
		21 split spoon	96-98	96-98	2.0/2.0	ML	96-98: clayey SILT, 60% silt, 40% clay, 5G 7/1 light greenish gray; low to med plasticity, hard, moist Note wet core barrel
		22 split spoon	98-100	98-100	2.0/2.0	ML	98-100: clayey SILT as above with slight increase in silt percentage (~~80~~% silt, ~~20~~% clay), and a trace of fine grained sand (<5%), low plasticity core barrel wet
100		cuttings					moist cuttings, no discontinuities
105		23 split spoon	104-105.7	104-105.7	1.7/1.7	ML	104-105.7: clayey SILT w/ trace v. fine sand; 70% silt, 25% clay, 5% fine grained sand; 5G 7/1 light greenish gray; low plasticity, hard; ~~moist~~ moist Note: wet core barrel
		cuttings					moist cuttings, no discontinuities
110		24 split spoon	109-111	109-111	2.0/2.0	ML	109-111: clayey SILT, 70% silt, 30% clay, 5GY 6/1 greenish gray; low plasticity, hard; med. moist note a 1 inch moist zone at approx 110ft Note: moist to wet core barrel
		cuttings					moist cuttings, no changes noted
115		25 split spoon	114-116	114-116	2.0/2.0	ML	114-116: clayey SILT same as 109-111, with ~~single~~ (a 1 inch fine grained sand at 109.2 ft, and black flecks + streaks not associated with bedding at random orientations. ~~5/12~~ 12-3-92 note: moist to wet core barrel

12-2-92

12-3-92

Field Bore Log

Test Hole

12-3-92 115
12-4-92

Depth (ft)	Well Construction	Sample Type and Number*	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
			114-116	114-116	2.0/2.0	ML	see above description (p. 4)
		cuttings					cuttings wet (hole sat overnight and accumulated water) same as above [green silty] note: most likely black clay contact at ~118 ft, not noted due to lag time in cuttings
120		26* split spoon	119-120.75	119-120 / 120-120.75	1.0/1.0 / .75/0.75	CL / ML	119-120: silty ~~CLAY~~, 70% clay, 30% silt, N 2.5/ black, med. plasticity, v. stiff, med. moist, marbled with 5GY 7/1 light greenish gray clayey silt increasing % w/ depth grading to below 120-120.75: clayey SILT, 5GY 7/1 light greenish gray, 65% silt, 35% clay, low plasticity, v. stiff, m. moist ~~silt~~ some v. fine ~~grn~~ sand occurring in thin (< 0.1 ft) lenses between 120 - 120.5
		cuttings					
125		27 split spoon	124-125.75	124-125.75	1.75/1.75	ML	124-125.75 clayey SILT 65% silt, 35% clay, 5GY 6/1 greenish gray, low to med. plasticity, v. stiff, m. moist
		cuttings					silty green cuttings are wet
130		28 split spoon	129-130.6	129-130.6	1.6/1.6	ML / ML	129.0-129.5 clayey SILT, same as 124-125.75 above / 129.5-130.6: clayey SILT, 75% silt, 25% clay, 5Y 5/2 olive gray, low plasticity, v. stiff, m. moist to moist
		cuttings					v. moist cuttings, no discontinuities
135		29 split spoon	134-135.75	134-135.75	1.75/1.75	ML	134-135.75: clayey SILT, 65% silt, 35% clay, 5GY 6/1 greenish gray, low to med plasticity, v. stiff, m. moist.
		cuttings					v. moist cuttings, no discontinuities
140		30 split spoon	139-140.75	139-140.75	1.75/1.75	ML	139-140.75 clayey SILT 60% silt 40% clay, 5GY 6/1 greenish gray, low to med plasticity, v. stiff, m. moist note: thin (< 0.1 ft) reddish sandy (fine grained) lense at 139.7
		cuttings					v. moist cuttings, no discontinuities
145		31 split spoon	144-145.2	144-145.2	1.2/1.2	SM	144-145.2 silty SAND, 70% sand (50% fine, 20% v. fine), 30% silt; 5GY 4/1 dark greenish gray, non-plastic, loose, wet
		cuttings					v. moist ~~wet~~ cuttings

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* containerized for VOC, BNA, and Agent Breakdown

S-93-92

Field Bore Log

Test Hole

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
							v. moist/wet cuttings
142		32 split spoon	142-150			ML	142-150 clayey silt: same as 139-140.75 above: moist TD = 150.0 ft
150							Boring terminated and well set after pulling up augers to 130 ft and water level was found to be at ~110 ft (40 ft. of water). AW 4/6/93 from field notes

12-4-92

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Well Construction Log

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs

SWMU No. South of SWMU 1

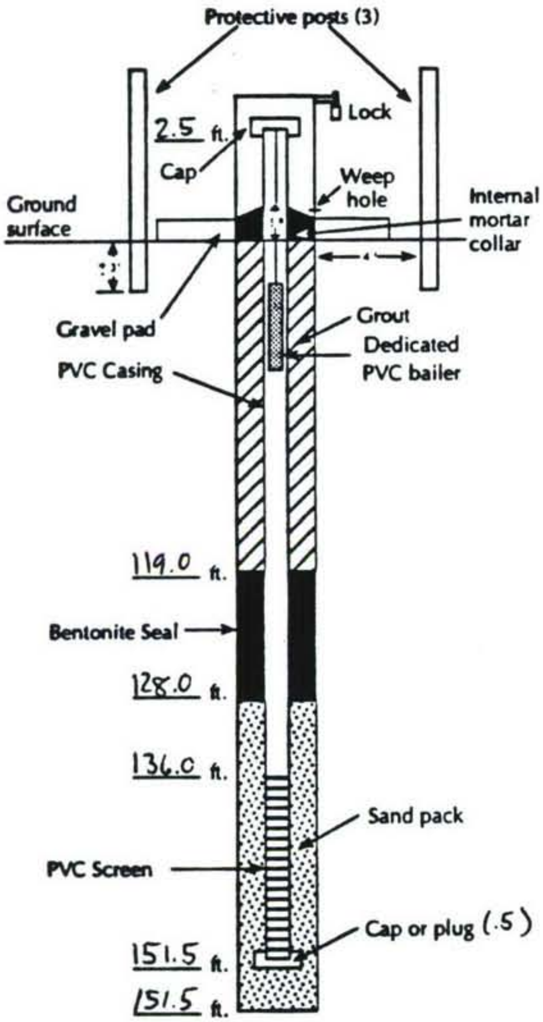
Field Geologist Conrad J. Bieniulis

Well No. S-93-92

Boring S-93-92

Installation Date 12-08 & 12-09-92

Checked by A Warner 4/6/93



Drilling Summary

Total depth 151.5 ft.

Borehole diameter 8"-HSA 7 7/8"-air inches

Drilling company Boyles Bros.

Driller Dean Walton

Helper Jake Lawrence

Rig Schramm - air B-57 - HSA

Method

- ☑ Hollow stem auger 0'-150'
- ☑ Air rotary 10'-151.5'
- ☑ Air rotary/driven casing 0'-10'
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout

Quantity 19 sx. cmt. ; 1 sx. bent. powder

Type Cement: Mountain Cement Co. - Portland Type I-II L.A (94 lbs. ea.)
Bentonite: pure bentonite powder (50 lbs. ea.)

Filter

No. ~~buckets~~ Sx. 5 (100 lb. ea.)

Sand type Colorado Silica Sand 10/20

Bentonite

Pellet size 1/4 inch

No. of buckets 2 (50 lb ea.)

Type American Colloid Co Volclay/Pure Gold

Screen

Length ☑ 10' ☑ 5' ☐ 20' (Total 15' screen)

I.D. ☑ 4" ☐ 3.826"

Slot size .010

Type PVC

Schedule (casing) ☑ 40 ☐ 80

Initial water level 110 ft.

Comments

Not to scale

Measuring point is ground surface unless otherwise noted.

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Development Record

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs
Geologist: J. Ostergren
Well No.: S-97-92
Date of Installation: 12-9-92

Well Information

Depth to water: ~~JPO 12-15-92~~ ~~AW 4/6/93~~ 66.6 ft. g.s.
Well depth: 151.5 ft. g.s.
Casing diameter: 4 ~~2~~ AW 4/6/93 in. to 151.5 ft. g.s.
Borehole diameter: 7 3/8 in. to 151.5 ft. g.s.
Amt. of mud/water lost during drilling: 0

PVC Casing stickup: 2.4 ft. g.s.
Screened interval: 136.0 to 151.0 ft. g.s.
Amt. of fluid in well (Prior to development)
In well casing: 57.0 gal } 68 gal/vol*
In sat. annulus: ~~38.8~~ JPO 12-17-92 gal } ~~95.8~~ gal/vol JPO 12-17-92 *
(30% porosity) 11.0 gal

Development

Date/time started: 12-15-92 / 1530
Completed: 12-17-92 / ~~1415~~ 1420 AW 4/6/93

Water level
Before development: 66.6 ft.
24 hrs. after: 70.05 ft.

Depth to sediment
Before development: none measured
After development: none measured

Measurement	pH	Elec. Conduct. (mmhos/cm @ ~~°C~~ AW 4/6/93) Temp(~~°C~~)	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	9.65	5230 @ 62.0°F	12-15-92	1530	0 gal	clear
1	8.43	5230 @ 57.0°F	12-16-92	1110	95 gal	cloudy, translucent
2	8.25	6130 @ 51.5°F	12-16-92	1220	190 gal	pale greenish gray; opaque
3	8.26	5810 @ 58.8°F	12-17-92	1017	285 gal	clear
4	8.14	5540 @ 56.4°F	12-17-92	~~[illegible]~~ 1135	380 gal	pale greenish gray; opaque
5	8.05	5530 @ 60.5°F	12-17-92	1415	475 gal	slight cloudiness, translucent
Extra purges					gal	
After development					gal	

Surge technique: None, only incidental with bailing action
Type, size and capacity of bailer or pump: PVC Bailer: 3 inch ID x 3 Ft (~1.1 gal capacity)
Quantity of fluid removed: 475 gallons
Time for removal: 1 day 22 hrs 45 min
Comments: "g.s." = measured from ground surface
~~will sample at 95 gallon increments, using 95 as approx gallons/vol.~~ JPO 12-17-92
Recovery rate measured as ≤ 2 min/ft for up to 1 hour from dry recovery,

Note: all depths measured from top of casing ~~[illegible]~~ JPO 12-17-92

Rev. 11/9/92 *Note: incorrectly calculated well volume initially as ≅95 gal/vol. (did not use 30% porosity for sandpack). Volumes removed = 475 gal/68 gal/vol ≅ 7 volumes.

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/N
SWMU 2
⊕ - Well S-95-92
Installation Boundary

Field Bore Log

Site Type Well
Site ID S-95-92 Dia. of Hole 0'-61' → 12-inch HSA; 61'-131' → 7 7/8" - Air Rotary
Date/Time Started 11-11-92 @ 1518
Date/Time Completed 11-18-92 @ 8:19
Surface Elevation
Water Level: Initial (ft.) ~~81.3~~ 72.2 AW 4/6/93 on 11-18-92
Completion Depth (ft.) 131.0
Drilling Company Boyles Bros.
No. Samples ~~13~~ 17 split spoons AW 4/12/93, 4 cuttings
Drilling Method Hollow-stem auger AND AIR ROTARY
Driller Bob Crews
Geologist/Date D.E. DeFerrais 11-11-92 (Signature)
Checked by/Date Alan Wanner 4/2/93

8 1/4 - inch augers, 140 lb hammer

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft)	Description Interval (ft)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
8/24/21/20	0		SS #1	0-2	0-0.5	1.15/2	ML	0-0.5 ft. = Silt w/ trace fine sand and ~~for~~ clay (clay = 5%, silt = 81%, fine sand = 14%). Moist, Not Plastic, Not cemented. 10YR 4/4 Dark Yel Bn
	1				0.5-4		ML	0.5-4 ft. = Silt w/ some clay + trace fine sand. (clay = 20%, silt = 66%, fine sand 14%). Med. to little moisture. Stiff. Not cemented. Low plasticity. 10YR 3/4 - Dk. Yel. Brown.
	2							
	3							
	4							
8/28/40/41	5		SS # 2	4-6	4-7.5	1.75/2	ML	4-7.5 ft. = clayey silt w/ trace fine sand. (clay - 30%, silt - 65%, fine sand - 5%). Med. moist. Low to med. plasticity. Very stiff to hard. Zones of white to clear evaporite xtals throughout. 10 YR 7/2 - light grey.
	6							
	7							
Finished Drilling @ 8ft. DEO 11-11-92	8				7.5-28			
	9	DEO 11-12-92						
4/28/54/60	10		SS #3	9-11	~~7.5-~~ DEO 11-11-92	2/2	ML	7.5-28 ft. = Clayey silt w/ ~~some~~ trace fine sand (clay = 30%, silt = 58%, fine sand = 12%). Low to med plasticity. Not cemented. Med. moist to moist. Very Stiff to Hard. 10YR 6/1 Light gray to gray. ~~clayey silt w/ some fine sand~~ DEO 11-11-92 Platey texture.
	11							
	12							
	13							
13/29/30/50	14		SS#4	14-16	14-16	2/2		@14 ft. = Same as above but slightly clayier. Med. plasticity. Moist. Light olive Gray - 5Y 6/2.
	15							
	16							
	17							
	18							@19 ft. = slightly drier and br... in color - 10YR 6/3 Pale Brown
	19							

Rev. 11/9/92
SS = Split Spoon.
@ = at

Well: S-95-92

Field Bore Log

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
20/32/45/50	19–21		SS # 5	19-21		2/2		@ 24 ft. = Low to Med. Plasticity. 10YR 6/2 - Light br. gray. Otherwise Same.
	21–24							
20/31/35/40	24–26		SS # 6	24-26		2/2		
Finished Drilling → 28 @ 28 ft. 11-12-92	26–29							
14/30/47/50	29–31		SS # 7	29-31		2/2	ML	29.0 - 31.0 ft. = clayey SILT w/ trace v.f. to fine sand. 80% silt, 30% clay, 10% sand. 2.5Y 5/1 Gray. Non to low plasticity, M to MST, L to MD, Dry
	31–34							
	34–36		SS # 8	34-36		2/2	CL	34.0 - 36.0 ft. = CLAY w/ trace silt, v.f. sand. 89% clay, 10% silt, 1% sand. 2.5Y 7/1 Light Gray. Low to med. plasticity, MST, MD to D, Dry.
	36–39							
	39–40.6		SS # 9	39.0-40.6		1.6/1.6	CL	39.0 - 40.6 ft. = CLAY w/ some silt. 80% Clay, 20% Silt. 2.5Y 7/1 Light Gray. Low plasticity, med. stiff, MD, Dry.
	40.6–41		SS #9	40.6-41		.4/.4	CL	40.6 - 41.0 ft. = Silty CLAY. 65% Clay, 35% Silt. non to low - plasticity, med. consis., loose, Dry. 5Y 6/2 Light Olive Gray.
	41–44							
14/35/47/50	44–46		SS # 10	44-46		2/2	CL	44.0-46.0 ft. = Silty CLAY. 70% clay, 30% Silt. non to low - plasticity, MST, MD, Dry. 5Y 6/2 Light Olive Gray. Interspersed veins of caliche throughout.
	46–49							
	49–50		SS #11	49-50		1.0/1.0	CL	49.0-50.0 ft. = Silty CLAY. 70% Clay, 30% Silt. Low to med. plasticity, MST, MD, Dry. 5Y 7/1 Light Gray.
50 for 5"	50–50.5		SS #11	50-50.5		.5/1.0	CL	50.0 - 50.5 ft. = Silty CLAY. 65% clay, 35% Silt. Low plasticity, med. consis., MD, Dry. 5Y 7/1 Light Gray.

Rev. 11/9/92

SS = Split Spoon
@ = at

Well: 5-95-92

Field Bore Log

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	50							
Finished Drilling at 52' on 11-13-92								54.0-54.4 ft. = CLAY w/ trace silt. 90% Clay, 10% Silt. Med. to high plasticity, med. consis., dense, dry. 5Y 6/1 Gray.
				54-54.4			CH	
14/33/31/48	55		SS #12	54.4-56		2/2	CL	54.4-56.0 ft. = silty CLAY. 35% Silt, 65% clay. non to low plasticity, M to MST, MO, dry 5Y 6/1 Gray.
Finished Drilling at 57' on 11-14-92								
15/20/45/50	60		SS #13	59-61		2/2	CL	59.0-61.0 ft = silty CLAY. 40% Silt, 60% Clay. non to low plasticity, med. consis, MD, dry 2.5Y 7/2 Light Gray. 60.5'-60.7' zone of clay nodules up to 1/2" diam. occupying approx. 25% of interval scattered throughout. Nodules are 2.5Y 8/1 white, dense, sub-rounded. WL measured at approx. 50'.
Finished Drilling at 61' on 11-15-92. Converted from HSA to air rotary.	65		Cuttings #14	64-66		NA	CL	64.0-66.0 ft. = silty CLAY. 40% Silt, 60% Clay. non-plasticity, med. consis., MD, dry. 2.5Y 6/2 Light Brownish Gray.
35/50/50	70		SS #15	69-71		2/2	CL	69.0-71.0 ft. = silty CLAY. 45% Silt, 55% Clay. non-plasticity, med. consis., L to MD, dry. 5Y 6/1 Gray.
	75		Cuttings #16	74-76		NA	CL	74.0-76.0 ft. = silty CLAY. 35% Silt, 65% Clay. low plasticity, med. consis., MO, dry. 5Y 6/1 Gray.
	80		Cuttings #17	79-81		NA	CL	79.0-81.0 ft. = same as 74-76'

Rev. 11/9/92

Well: S-95-92

Field Bore Log

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	80							
	85	Top of Bentonite Seal = 84'	Cuttings #18	84-86		NA	CL	84.0'-86.0' = same as 74'-76'
Finished drilling at 89' on 11-16-92								
35/50	90		SS #19	89-90		1.0/2.0	CL	89.0'-90.0' = silty CLAY. 40% Silt, 60% Clay. non to low plasticity, med. consis., MD, dry. 2.5Y 8/1 white. Refusal at 90'.
	95							
		Top of Filter Pack = 97'						90.0'-109.0' = poor recovery of cuttings - no samples taken; no water recovered during drilling
	100							100.0'-107.0' = drilling break reported
		Top of Screen = 102.5'						
	105							
38/38/50/50	110		SS #20	109-111		2/2	CL	109.0'-110.0' = silty CLAY. 45% Silt, 55% Clay. non plasticity, med. consis., MD, dry. 5Y 6/1 Gray

Rev. 11/9/92

Well: S-95-92

Field Bore Log

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	110							
								113'-119' = drilling break reported
	115							111'-129' = poor recovery of cuttings, several surges of clay with water either from 56'-59' or possibly below 100'. no samples taken
	120							
	125							
Finished drilling at 129' on 11-17-92		Bottom of Screen = 127.5'						
		Bottom of Sump = 128'						
50/37/50	130	TD: 131'	SS#20	129-131		2/2	CL	129'-131' = silty CLAY. 40% silt, 60% clay. non to low plasticity, med. consis., MD, dry. 5Y 6/2 Light olive Gray. WL measured at 72.2'.
Total Depth at 131' on 11-18-92								
	135							BORING TERMINATED AT 131 FEET, hole was left open overnight for 16 hours and 58.8 ft of water was observed.
	140							

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EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Construction Log

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs

SWMU No. South of SWMU 25

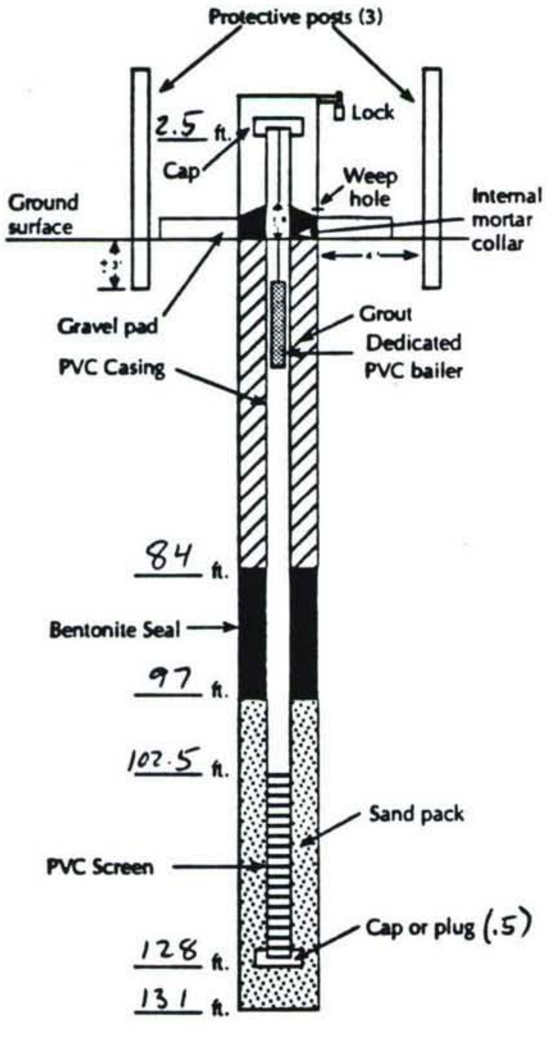
Field Geologist: Conrad J. Bieniulis

Well No. S-95-92

Boring: S-95-92

Installation Date: 11-19-92

Checked by: [signature] 4/2/93



Not to scale

Measuring point is ground surface unless otherwise noted.

Drilling Summary

Total depth: 131.0 ft.

Borehole diameter: 12" - HSA 7 3/8" - air inches

Drilling company: Boyles Bros.

Driller: Robert Crews

Helper: Jake Lawrence

Rig: Schramm - HSA & air rotary

Method
- ☑ Hollow stem auger 0'- 61'
- ☑ Air rotary 61'- 131'
- ☑ Air rotary/driven casing 0'- 70'
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout
- Quantity: 18 - cmt. 3 - bent. powder
- Type: Cement - Mountain Cement Co. - Portland Type I - II L.A. (low alkali) 94 lbs. ea.
  Bentonite - pure bentonite 50 lbs ea.

Filter
- No. ~~buckets~~ sacks (100 lb. ea.) 6
- Sand type: Colorado Silica Sand 10/20

Bentonite
- Pellet size: 1/4 inch
- No. of buckets: 3 (50 lb. ea.)
- Type: American Colloid Co. Volclay / Pure Gold

Screen
- Length: ☐ 10' ☐ 20' Total: 25' 2 - 10' 1 - 5'
- I.D.: ☑ 4" ☐ 3.826"
- Slot size: .010
- Type: PVC
- Schedule (casing): ☑ 40 ☐ 80
- Initial water level: 81.3 ft. (on 11-19-92)

Comments

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Development Record

Project: TEAD - South Area, RFI - Phase II - Group 1 SWMUs
Geologist: DePersis / Ostergren
Well No. S-95-92
Date of Installation: 11-19-92

Well Information

Depth to water: 29.7 (TOC) ft.
Well depth: 130.3 (TOC) ft.
Casing diameter: 4 in. to 131 ft.
Borehole diameter: 7 7/8 in. to 61-131 ft.
Amt. of mud/water lost during drilling: 150 gallons
Casing stickup: 2.3 ft.
Screened interval: ~~104.8 TOC~~ 102.5 ft to ~~130.3 TOC~~ 127.5 ft AW 4/6/9-
Amt. of fluid in well (Prior to development)
In well casing: 65.93 gal. } ~85 gal
In sat. annulus (30% porosity): 18.92 gal
Gallons per volume = 150 + 65.93 + 18.92 = 234.55 ≈ 235 gal/vol.

Development

Date/time started: 12-02-92 @ 15:35
Completed: 12-15-92 @ 10:56

Water level
Before development: 29.7 ft. (TOC)
24 hrs. after: 81.3 ft.

Depth to sediment
Before development: 128.8 ft (TOC)
After development: not measureable

Measurement	pH	Elec. µs Conduct. ~~(mmhos/cm @ °C)~~ °F AW 4/6/93 Temp(~~°C~~) °F	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	8.15	1069 @ 55.7	12-2-92	15:40	0 gal	clear water, w/v. light gray fine sediment
1	STOP BAILING, WELL DRY		12-2-92	TOTAL 48 gal removed	gal	
2	7.77	7480 @ 51.5	12-3-92	09:23	90* gal	v. light gray/muddy
3	STOP BAILING, BEGIN TO SURGE		12-3-92	TOTAL 100 gal removed	gal	
4	RESUME/STOP BAILING		12-4-92	TOTAL 160 gal removed	gal	
5	RESUME/STOP BAILING		12-5-92	TOTAL 178 gal removed	gal	
AW 4/6/93 Extra purges	7.95	1080 @ 47.0	12-6-92	08:19	180 gal	clear, v. slight cloudiness
After development	7.97	1040 @ 56.4	12-7-92	15:30	225 gal	clear

Surge technique: No surge block, etc. used from 0-100 gal. Began surging after 100 gal for ~1¼ hours
Type, size and capacity of bailer or pump: PVC bailer 3" ID x ~10 ft. (3.5 gal/bail)
Quantity of fluid removed: 400 gallons
Time for removal: Intermittent over 13 days
Comments: Sediment on bottom of well before development - light gray and very fine. Recovery in well on 12/3/92 morning was minimal ~43.5 ft below first water level before bailing. [illegible] that formation producing water is "tight" and water added to hole to set well has probably not migrated far and "halo" of effects ~~[illegible]~~ 4/6/93 from well installation/drilling are probably not extending far from hole.

Note: all depths measured from top of casing

Rev. 11/9/92

* Measured parameters every 90 gallons although a volume was 235 gallons, in order to get a better indication of trends during development. (NOTE: 12/6 & 12/7 conductivity values in question due to misreading/printing meter values)

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Development Record

Project: TEAD - South Area, RFI - Phase II - Group 1 SWMUs
Geologist: DePersis / Ostergren
Well No. S-95-92
Date of Installation: 11-19-92

Well Information

Depth to water: 29.7 (TOC) ft.
Well depth: 130.3 (TOC) ft.
Casing diameter: 4 in. to 131 ft.
Borehole diameter: 7 3/8 in. to 131 ft.
Amt. of mud/water lost during drilling: 150 *
(* volume added)

Casing stickup: 2.3 ft.
Screened interval: 104.8 TOC to 130.3 ft.
Amt. of fluid in well (Prior to development)
In well casing: 65.93 gal } ~85 gal
In sat. annulus (30% porosity): 18.92 gal }
WELL VOL = 85 + 150 = 235 gal

Development

Date/time started: 12-2-92 @ 15:35
Completed: 12-15-92 @ 10:56

Water level
Before development: 29.7 ft (TOC)
24 hrs. after: 81.3 ft.

Depth to sediment
Before development: 128.8 ft. (TOC)
After development: not measureable

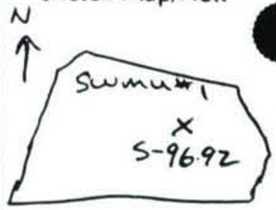
Measurement	pH	Elec. Conduct. ~~(mmhos/cm)~~ us/cm @ ~~°C~~ °F Temp(~~°C~~) °F (RW 4/6/93)	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	7.97	9750 @ 57.5	12-9-92	08:22	270 gal	translucent, v. lt. gray
1	RESUME/STOP BAILING		12-10-92	TOTAL	305 gal removed gal	
2	8.51	11,500 @ 47.5	12-12-92	11:10	315 gal	very slightly cloudy
3	8.02	9,080 @ 54.9	12-13-92	09:45	360 gal	very slightly cloudy
4	STOP BAILING		12-13-92	TOTAL	374 gal removed gal	
5 (RW 4/6/93)	8.26	10,560 @ 52.0	12-15-92	10:56	400 gal	v. slightly cloudy (translucent)
Extra purges					gal	
After development					gal	

Surge technique: WITH BAILER
Type, size and capacity of bailer or pump: PVC BAILER ~3.5 gal/bail
Quantity of fluid removed: 400 gal
Time for removal: Intermittent over 13 days
Comments:

Note: all depths measured from top of casing

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Note



Field Bore Log

Site Type Well
Site ID S-96-92
Dia. of Hole 10 inch
Date/Time Started 11-13-92 / 11:35
Date/Time Completed 11/18/92 (well completed) TIME 11:23
Surface Elevation
Water Level: Initial (ft.) in core: ~~99 ft~~ JDO 11-18-92 109 ft; in open hole: 78.5; in well: 67.9
Completion Depth (ft.) 114.9 ft*
Drilling Company Boyles Bros.
No. Samples 22
Drilling Method HSA
Driller Jay Hulse
Geologist/Date [signature] (Signature)
Checked by/Date A. Warner 4/4/93

~~* drilled to 114.0~~ JDO 11-18-92

Begin Augering at ~~about~~ 0 on 11-13-92

11-14-92 Begin Augering at approx 6.0 ft

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–4	grout	cuttings					0-4.0: clay-rich cuttings similar to below
4–6	grout	① Split spoon	4.0-6.0 ft.	4.0-6.0 ft	1.8/2	CH	4.0-6.0: silty clay ~~with trace fine grained sand~~ JDO 11-13-92 (clay 60%, silt ~~40%~~ JDO 11-13-92), 5YR 8/1 white to 5YR 7/1 light gray, med to high plasticity, ~~stiff~~ JDO 11-13-92 firm, dry
6–9	grout JDO 11-18-92	cuttings					No major changes noted
9–11	JDO 11-18-92	Split spoon 2	9.0-11.0 ft	9-10.0 ft; 10-11 ft	1/1; 1/1	~~CH~~ CL JDO 11-14-92; ML	9.0-10.0 ft: silty CLAY ~~JDO 11-14-92~~ with trace caliche (60% clay, 40% silt) 5Y 7/1 light gray, med ~~stiff~~ stiff plasticity, dry. 10-11 ft: clayey silt (~~60%~~ 70% silt, ~~40%~~ 30% clay) 10YR 7/3 very pale brown, low to med plasticity, medium consistency, dry
11–14	grout	cuttings					No major changes noted.
14–16		split spoon 3	14-16 ft	0.4/0.4; 1.4/1.6	1.8/2.0	~~SM~~ CL JDO 11-14-92; ML and CH	14.0-14.4 Same as 9.0-10.0 ft above. 14.4-16.0 alternating sequences (alft each) of silty CLAY and clayey SILT (reversing percentages of ~~approx~~ JDO 65-70% to 35-30%), 5Y 8/1 white, alternating low ~~JDO to~~ 11-14-92 and med to high medium plasticity, soft, dry
16–18		cuttings					No major changes noted

Rev. 11/9/92

Field Bore Log

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
20		4 split spoon	19.0-21.0 ft	19.0-21.0	2.0/2.0 ft	ML	19-21.0 clayey SILT with trace caliche occurring in isolated ~~pockets~~ lenses (JBP) (<1/4" thick) 65% silt, 35% clay, 5Y 7/3 pale yellow with lowermost 0.3ft 5Y 8/2 white, low to med plasticity, soft, dry
		cuttings					appears to coarsen with depth
25		5 split spoon	24-24.85ft	24-24.85ft	0.85/0.85 ft	SM	24-24.85 silty very fine-grained SAND 70% very fine-grained sand, 30% silt, 5Y 8/1 white, non-plastic, loose, d.
		cuttings					apparently fining with depth
30		6 split spoon	29-31.0 ft	29-31.0 ft	2.0/2.0 ft	ML	29-31.0 clayey SILT, 60% silt, 40% clay, 5Y 7/2 light gray, soft, low to med. plasticity, dry
		cuttings					apparently fining with depth
35	grout	7 split spoon	34.0-36.0 ft	34.0-36.0 ft	2.0/2.0 ft	CL	34.0-36.0 silty CLAY; 65% clay, 35% silt, 5Y 8/2 white, soft to med. stiff, medium plasticity, dry
		cuttings					apparently coarsening with depth
40		8 split spoon	39.0-41.0 ft	39.0-41.0 ft	2.0/2.0 ft	ML	39.0-41.0 clayey SILT; 70% silt, 30% clay, 5Y 8/2 white, med. stiff, low to med. plasticity, dry
		cuttings					no ~~there~~ JBP 11-14-92 major changes noted
45		9 split spoon	44.0-46.0 ft	44.0-46.0 ft	2.0/2.0 ft	ML	44.0-46.0 clayey SILT; 60% silt 40% clay, 5Y 7/3 pale yellow, med. stiff, low to mod. plasticity, dry
		cuttings					Apparently fining with depth
50		10 split spoon	49.0-51.0 ft	49.0-51.0 ft	2.0/2.0 ft	CL	49.0-51.0 silty CLAY; 70% clay, 30% silt; 5Y 8/2 pale yellow; very stiff; med. plasticity; ~~dry~~ JBP 11-15-92 low moisture

Augered 11-14-92

Augered 11-15-92

Rev. 11/9/92

Field Bore Log

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
51.0 / 52.0 / 53.0 (JDG 20 11-15-92)	grout	cuttings					No major changes noted
54.0 / 55.0		11 split spoon	54.0-56.0 ft	54.0-56.0 ft	2.0/2.0 ft	CL	54-56.0 silty CLAY; 75% clay, 25% silt; 5Y 8/2 pale yellow very stiff to hard; med-plasticity; low moisture
(JDG 25 11-15-92)		cuttings					No major changes or discontinuities noted
60.0		12 split spoon	59.0-61.0 ft	59.0-60.3 ft	1.3/1.3	CL	59.0-60.3 silty CLAY, 60% clay, 40% silt; 5Y 6/2 light olive gray very stiff to hard; low to med plasticity; low moisture minor lt olive green veinlets at ~~approx~~ 60 ft
				60.3-61.0 ft	0.7/0.7	ML	60.3-61.0 clayey SILT; ~~60% silt, 40% clay,~~ JDG 11-15-92 5Y 7/2 light gray; 70% silt, 30% clay; very stiff to hard, none to low plasticity; low moisture
(JDG 30 11-15-92)		cuttings					No major changes noted
65.0		13 split spoon	64.0-66.0 ft	64.0-66.0 ft.	2.0/2.0 ft	ML	64.0-66.0 clayey SILT; 70% silt, 30% clay; 5Y 7/1 light gray; very stiff to hard; none to low plasticity; low moisture; some v. small white flecks throughout
(JDG 35 11-15-92)		cuttings					~~apparently fining with depth~~ JDG 11-15-92 No major discontinuities noted
70.0		14 split spoon	69.0-71.0 ft	69.0-71.0 ft	2.0/2.0 ft	CL	69-71 ft silty CLAY; 70% clay, 30% silt; 5Y 6/2 light olive gray; stiff; low to med. plasticity; low moisture;
(JDG 40 11-15-92)		cuttings					No major discontinuities noted, although apparently coarsening with depth
75.0		15 split spoon	74.0-76.0 ft.	74.0-76.0 ft.	2.0/2.0 ft	ML	74-76 ft. clayey SILT; 70% silt, 30% clay; 10YR 7/1 - Light gray; very stiff; low plasticity; low moisture. Minor iron concentrations w/ localized iron staining in lower portion
(JDG 45 11-15-92)		cuttings					No major discontinuities noted
80.0		16 split spoon	79.0-81.0 ft.	79.0-81.0 ft.	2.0/2.0 ft.	CL	79-81 ft. Silty CLAY, 25% silt, 75% clay, ~~10~~ 5Y 6/2 - Light olive gray; very stiff; low plasticity; low moisture (JDG 11-15-92)
(JDG 50 11-15-92)	Top of seal 83.0 ft						No major changes noted

Rev. 11/9/92

Field Bore Log

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
83.0	Top of seal 83.0 ft.	cuttings					No major changes noted
1130 11-16-92 / 85	1/4" bentonite pellets	17 split spoon	84.0-86.0 ft	84.0-86.0 ft	2.0/2.0	CL	84-86 ft: silty CLAY. 75% clay, 25% silt; 5GY 6/1 greenish gray; very stiff; low to med. plasticity; low moisture
		cuttings					No major changes noted
1200 11-16-92 / 90		18 split spoon	89.0-91.0 ft	89.0-91.0 ft	2.0/2.0	CL	89-91 ft: silty CLAY; 75% clay, 25% silt; 5GY 6/1 greenish gray; stiff; low to med. plasticity; low to med. moisture; dark grey (N4/) to black (N2.5/) marbling in lower foot, increasing in space percentage with depth to abundant in lowermost 0.1 ft, showing no apparent textural preference or depositional layering (i.e. "marbled"). Minor (<0.2 ft) silt-rich layer at approx 90.7 ft.
		cuttings					cuttings very dark and clay-rich.
1220 11-16-92 / 95	Top of sandpack 94.5 ft	19 split spoon	94.0-96.0 ft	94.0-96.0 ft	2.0/2.0	CL	94-95 ft: silty CLAY; 70% clay, 30% silt; 5GY 6/1, greenish gray; stiff to v. stiff; low to med plasticity; low moisture; uppermost 0.1 ft is black clay with some silt grading (marbling) into greenish gray silty clay
		cuttings					No major changes noted, although apparently coarsening with depth
1325 11-16-92 / 100	Top of screen 99.5 ft	20 split spoon	99.0-101.0 ft	99.0-101.0 ft	2.0/2.0	ML	99-101 ft: clayey SILT; 60% silt, 40% clay; 5GY 7/1 light greenish gray; v. stiff; low plasticity; low to med. moisture; slight grading from clay-rich in the uppermost 0.1 ft; trace black flecks noted throughout (~1%)
		cuttings					No major changes noted, although apparently coarsening with depth
1400 11-16-92 / 105		21 split spoon	104.0-106.0 ft	104.0-106.0 ft	2.0/2.0	ML	104-106: clayey SILT with trace v. fine grained sand; 70% silt; 25% clay; 5% v. fine grained sand; 5GY 7/1 light greenish gray; v. stiff to hard; no to low plasticity; low to med. moisture
		cuttings					No major changes noted, although apparently coarsening with depth
0900 11-16-92 / 110		22 split spoon	109.0-111.0 ft	109-110 ft	1.0/1.0	ML	109-110: clayey SILT; 75% silt, 25% clay; 5GY 6/1 greenish gray; v. stiff to hard; no to low plasticity; med. moisture
				110-111 ft	1.0/1.0	ML	110-111: sandy SILT with some clay; 5GY 6/1 greenish gray; med. consistency; med. dense; no to low plasticity; moist (50% silt, 26% v. fine grained sand, 24% clay). Slight plasticity may, however, indicate clay > sand.
		cuttings					clay-rich cuttings noted (greenish as above)
1300 11-18-92 / 114.6	Bottom of screen 114.6 ft		11-18-92				

TD 114.9 ft

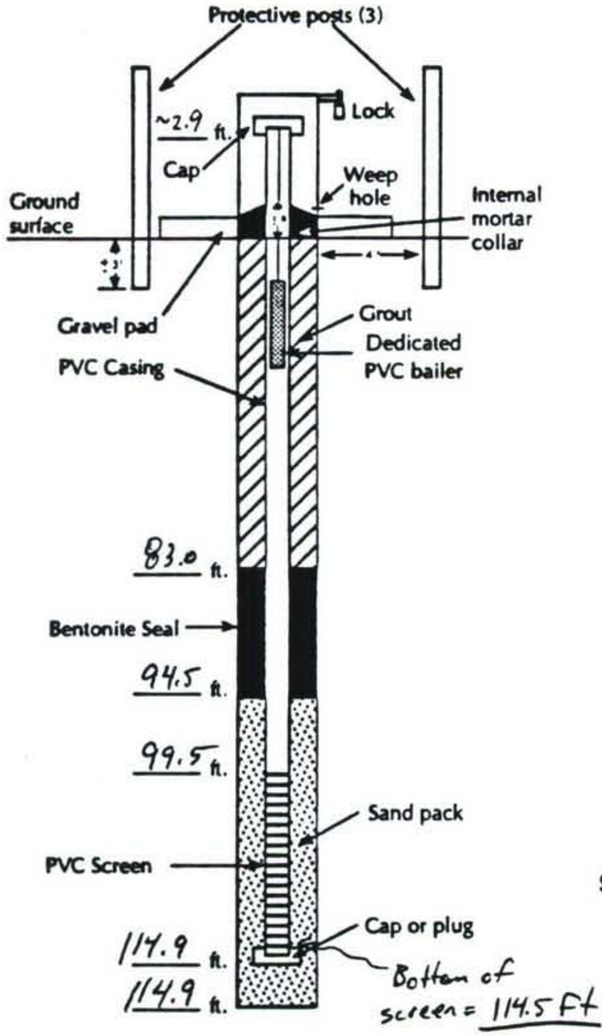
Rev. 11/9/92 Boring stopped due to encountering water, approx. 5 feet after drilling to 109 ft. Proceeded deeper to ensure top of screen would not be in confining layer. AW 4/4/93

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Construction Log

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs
SWMU No. 1
Field Geologist: J. Ostergren / D. DePersis

Well No. S-96-92
Boring: S-96-92
Installation Date: 11-17-92, 11-18-92
Checked by: A Warner 4/4/93



Not to scale

Measuring point is ground surface unless otherwise noted.

Drilling Summary

Total depth: 114.0 ft.
Borehole diameter: 10.0 inches
Drilling company: Boyles Bros.
Driller: J. Hulse
Helper: W. Franklin
Rig: Mobile B-57
Method:
- [x] Hollow stem auger
- [ ] Air rotary
- [ ] Air rotary/driven casing
- [ ] Mud rotary
- [ ] Other

Well Construction Materials

Grout
Quantity: ~~20~~ 30 11-18-92 23 bags
Type: 20:1 Portland cement : bentonite w/ 8 gal. USATHAMA approved H_2O per 94 lb bag of cement

Filter
No. buckets: 10 x 100 lb bags
Sand type: Colorado Silica Sand 10/20

Bentonite
Pellet size: 1/4 inch
No. of buckets: 2
Type: Bentonite (PureGold)

Screen
Length: [ ] 10' [x] 15' [ ] 20'
I.D.: [x] 4" [ ] 3.826"
Slot size: .010
Type: PVC
Schedule (casing): [x] 40 [ ] 80
Initial water level: 78.55* ft. (pre-well installation)
post-well installation 67.8 ft.
in core 109 ft

Comments

① 15 foot screen used
② water level at 78.55 ft after approx 12 hours with hole drilled to 110 ft.
③ dry clay logged to 99 ft, coarsening to silt below. (showing some moisture). Therefore conditions are confined and we are screening the productive material. Moisture in hole first noted at 109 ft

Rev. 11/9/92

* see comment #3

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Well Development Record

Project: TEAD - South Area, RFI - Phase II - Group 1 SWMUs

Geologist: D. E. DePersis

Well No. S-96-92

Date of Installation: 11-17-92 and 11-18-92

Well Information

2 HyDACs used: Ser. # 9209A + ~~9208B~~ 9209B

Depth to water: 69.7 ft. (TOC) ft.

Casing stickup: 2.4 ft.

Well depth: 117.3 ft. (TOC) ft.

Screened interval: 101.9 (TOC) to 116.9 → (TOC) ft.

Casing diameter – ID: 4 in. to TD ft.

Borehole diameter: 10 in. to TD ft.

Amt. of fluid in well (Prior to development): → + 2.5 gallons (total) added during well installation.

In well casing: 31.07 gal.

In sat. annulus: 20.97 gal (30% porosity)

Amt. of mud/water lost during drilling: 2.5 gal. total

Each Vol. (gal) = 2.5 + 31.07 + 20.97 = 54.54 ≈ 55 gal.

Development

Date/time started: 11-30-92 @ 1453

Completed: ~~11-30-92~~ 12-02-92 @ 1248

Water level

Before development: 69.7 (TOC) ft.

24 hrs. after: 69.66 ft. 12/12/92 MB

Depth to sediment

Before development: ~107 ft. (TOC)

After development: ~117.3 ft. (TOC) (No sediment at bottom of hole in measurable quantity.)

Measurement	pH	Elec. Conduct. µS ~~(mmhos/cm @ °C~~ Temp(~~°C~~) °F	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial *	7.84	4710 / 49.6 °F	11-30-92	1455	0 gal	Clear water from above underlying fine gray sediment
1 *	7.81	6300 / 55.0 °F	11-30-92	1640	55 gal	lt. grey, muddy.
→ Stopped bailing for the day after 55 gal. total removed.						
2	7.70	4280 / 62.0 °F	12-01-92	1034	110 gal	lt. grey, cloudy - clearer than above.
3	7.87	4100 / 51.6 °F	12-01-92	1354	165 gal	v. lt. gray, cloudy, clearing.
→ Stopped bailing for the day after 210 gal. total removed.						
4a	7.81	4340 / 51.9 °F	12-02-92	0849	220 gal	v. lt. gray, slightly cloudy
4b	7.86	5930 / 55.0 °F	12-02-92	0927	247.5 gal.	v. lt. gray, v. slightly cloudy
5a	7.87	6960 / 52.4 °F	12-02-92	1049	275.0 gal	v. lt. gray, v. slightly cloudy
5b	7.89	** 6470 / 56.7 °F	12-02-92	1248	~~302~~ 306 gal.	Mostly clear.
Extra purges					gal	
After development	} N/A	– See		Above	12-02-92 gal	{

* NOTE – "Sewer" odor 0-55 gal. No HNU readings, however, > bkgd.

** Note that this conductivity reading taken w/ Hydac 9209B, as 9209A appeared to malfunction for conductivity.

Surge technique: No surge block, etc. used.

Type, size and capacity of bailer or pump: 3-inch ID X ~10 ft. PVC bailer (~3½ gal. capacity).

Quantity of fluid removed: 306 gal.

Time for removal: Bailed for a total of approx. 13 hrs of bailing/recovery time.

Comments: Recovery was not sufficient to keep up with continuous bailing, therefore well bailed for ~¾ to 1 hr. periods then allowed to recover for ~½ to ⅓ hr. periods. Note that based on field observations first 10 feet of recovery is relatively faster than remaining recovery – rate tapers off.

Note: all depths measured from top of casing

Rev. 11/9/92

ABBREVIATIONS:
ID = Inner Diameter
TD = Total Depth of Hole
> = greater than
gal = gallons
TOC = Top of Casing (PVC)
bkgd = background
hr. = hour
Vol. = volume

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Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Note

Field Bore Log

Site Type Well — Site ID S-97-92 — Dia. of Hole 7 3/8"

Date/Time Started 11-19-92 1600 — Date/Time Completed 12-02-92 1446 (hrs)

Surface Elevation ______ — Water Level: Initial (ft.) 69.0

Completion Depth (ft.) 83.5 — Drilling Company Boyles Bros. — No. Samples ~~13~~ 11 AW 4/4/93 - split spoon; ~~8~~ 9 - cuttings

Drilling Method HSA / Air Rotary — Driller J. Hulse, D. Walton

Geologist/Date Conrad J. Brimilis 12-02-92 (Signature) — Checked by/Date A. Warner, 4/4/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0–4		cuttings					Sand and fine gravel aded in matrix of fines
4.0–4.9 (11-19-92)	4.0 4.9	1 split spoon	4.0-4.9	4.0 4.9	0.9/0.9 ft	SM	4.0-4.9 silty SAND with some fines and ~~pebbles~~ coarse fine gravel JDO 11-19-92; 40% sand, 30% silt, 20% clay, 10% small pebbles; 5YR 6/3 light reddish brown; no plasticity; loose, dry, poorly sorted, possibly slough material from near surface; sands from v. fine through coarse
5–9		cuttings					
9–11		2 split spoon	9.0-11.0	9.0-11.0	1.9/2 ft	CL	9-11 ft silty CLAY with trace caliche flecks; 70% clay, 30% silt; 10YR 6/3 pale brown; med plasticity; stiff; dry
11–14		cuttings					Clay-rich cuttings (as above)
14–16 (~~11-19-92~~ JDO 11-19-92)		3 split spoon	14-16 ft	14-16 ft	1.5 ft/2.0 ft	ML	14-16 ft: clayey SILT with trace caliche flecks, moisture & fine grained sand JDO 11-19-92; 65% silt, 35% clay; 10YR 7/2 light gray; stiff; low plasticity; dry; 14.0-14.1 clay-rich as 9-11 above.
16–19		cuttings					Clayey silt w/ trace v. fine grained sand (same as above)

Rev. 11/9/92

Field Bore Log 5-97-92

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
20 (11-19-92)		4 split spoon	19.0 - 21.0	19.0 - 21.0 ft	1.5/2.0	SM	19-20 silty SAND; sand v. fine to coarse grained sand; 60% sand 40% silt; 10YR 6/2 light brownish gray; non plastic; loose; dry
						GM	20-21 sandy GRAVEL, ~~sand v. fine~~ with some fines; 50% gravel, 30% sand; 20% fines; 10YR 6/2 light brown gray; non-plastic; med. density; dry; sands fine to coarse gravels fine, all grains sub-angular to angular gravels predominantly ~~...~~ fine-grained ... TDD 11-19-92
		cuttings					
25	NOT TAKEN SEE NEXT PAGE AW 4/4/93	5 split spoon	24.0 -	24.0 -			
		cuttings					
30		6 split spoon	29.0 -	29.0 -			
35							
40							
45							
50							

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Note: Sample #4 19-21 ft is composite of units SM and GM due to lack of material and gradational contact

Field Bore Log S-97-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
Started drilling w/air rotary at 20' on 12-01-92	20							20'-21' No recovery. See previous description
40,50			SS #7	21-21.7 21.7-22	21-21.7 21.7-22	1.0/2.0	GW ML	21'-21.7' sandy GRAVEL w/ tr. silt. 70% Gravel, 20% Sand, 10% silt. Dry. Gravels: sub-rounded to angular limestone, color ranging from gray (6/1, 2.5Y) to dark. gray (4/1, 2.5Y), size ranging from mostly .1" or .2" up to 1.8". Sand: fine to v. coarse pale yellow (7/4 2.5Y) Silt: pale yellow (7/4 2.5Y) 21.7'-22.0' SILT w/ trace clay. 90% Silt, 10% Clay. very pale brown (7/3 10YR), non plastic, MST, MD, Dry.
			Cuttings	23-24	23-24	NA	ML	23.0'-24.0' SILT w/ some clay. 80% Silt, 20% clay. pale brown (6/3 10YR), non plastic, Dry.
	25							
17,27,29,32	30		SS #8	29-29.25 29.25-31.0	29-29.25 29.25-31.0	2.0/2.0	GM ML	29'-29.25' silty GRAVEL w/some sand. 35% Silt, 50% Gravel, 15% Sand. Dry. Gravels: sub-rounded to angular limestone, color ranging from gray (6/1, 2.5Y) to dark. gr (4/1, 2.5Y), size ranging from mostly .1" to .3" up to a few at .8". Sand and silt: very pale brown (7/3 10YR). 29.25'-31.0' clayey SILT. 20% Clay, 80% Silt. Dry. non-plastic, MST, MD. Light yellowish brown (6/4 10YR).
	35		Cuttings	34'-36'	34'-36'	NA	CL	34'-36' silty CLAY. 35% Silt, 65% Clay. Dry. Non to low plasticity, med. to MST. Light yellowish brown (6/4 10YR).
18,35,50	40		SS #9	[illegible]	[illegible]	1.5/2.0	CL ML	39'-39.5' No recovery. 39.5'-39.8' silty CLAY w/ trace gravels. Dry. non-plastic, med. to MST, MD. 30% Silt, 60% Clay, 10% Gravels. Gravels: dark. gray (4/1, 2.5Y) sub-rounded limestone. Silty clay: light gray (7/2 10YR) 39.8'-41' SILT w/ tr. v. fine sand and clay. Very pale brown (8/2 10YR). Dry. 85% Silt, 5% Sand, 10% Clay. Med. consis., MD.
	45		Cuttings	44'-46'	44'-46'	NA	ML	44'-46' clayey SILT. 30% Clay, 70% Silt. non-plastic, Dry.

50

Field Bore Log S-97-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
14,27,21,35	50		SS #10	49-49.4	49-49.4	2.0/2.0	CL	49'-49.4' silty CLAY w/ some gravels. 20% Silt, 65% Clay, 15% Gravels. Lt. brownish gray (6/2 2.5Y). MST, MD, Dry. Gravels: caliche and limestone. Clay: non-plastic to low plasticity.
				49.4-50.6	49.4-50.6		ML	49.4-50.6' clayey SILT. 25% Clay, 75% Silt. Lt. Gray (7/2 2.5Y) MST, MD, Dry, non-plastic.
				50.6-51	50.6-51		ML	50.6'-51' clayey SILT. 25% Clay, 75% Silt. Lt. Gray (7/2 10YR) MST, MD, Dry, non-plastic.
	55		Cuttings	54-56	54-56	NA	ML	54'-56' clayey SILT. 35% Clay, 65% Silt. Pale brown (6/3 10YR). Dry. Non-plastic.
9,21,[illegible],50	60	Top of Bentonite Seal = 59'	SS #11	59-60.6	59-60.6	2.0/2.0	ML	59'-60.6' clayey SILT. 20% Clay, 80% Silt. Pale Brown (6/3 10YR) to Lt. Gray (7/2 10YR). MST, MD, Dry.
				60.6-61	60.6-61		ML	60.6'-61.0' clayey SILT w/ some gravels. 25% Clay, 65% Silt, 10% Gravels. Lt. Brownish-Gray (6/2 2.5Y). MST, MD, Dry.
	65	Top of Filter Pack = 65.0'	Cuttings	64-66	64-66	NA	CL	64'-66' silty CLAY. 35% Silt, 65% Clay. Lt. yellowish-brown (6/4 10YR). Dry. Non to low plasticity.
25,50	70		SS #12	69-71	69-71	2.0/2.0	ML	69'-71' clayey SILT. 25% Clay, 75% Silt. Lt. Yellowish-Brown (6/4 10YR). Med. consis, MD, Dry, non-plastic.
		Top of Screen = 72.5'						
	75		Cuttings	74-76	74-76	NA	ML	74'-76' clayey SILT. 25% Clay, 75% Silt. very pale brown (7/3 10YR). Non-plastic, Dry.

Field Bore Log S-97-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
			SS #13	79-79.3	79-79.3	1.3/2.0	CL	79'-79.3' silty CLAY w/ caliche nodules. 25% Silt, 75% clay. Very pale brown (7/3 10YR). Soft, loose, low plasticity, dry. Nodules: gravel to pebble sized, white (8/1 10YR) included in clay percentage.
21,50	80			79.3-80.3	79.3-80.3		ML	79.3'-80.3' clayey SILT. 20% clay, 80% silt. white (8/1, 10YR). MST, MD, Dry. Non-plastic.
								80.3'-81.0' No recovery
Finished drilling at 83.5' on 12-02-92		Bottom of Screen = 82.5'						
		Bottom of Sump = 83.0'						
Total Depth at 83.5' on 12-02-92		TD = 83.5'						
	85							
	90							
	95							
	100							
	105							

TERMINATED DRILLING AT 81 FEET AND SET WELL BECAUSE 12 FEET OF WATER FILLED BORING OVERNIGHT (~16.5 hours).

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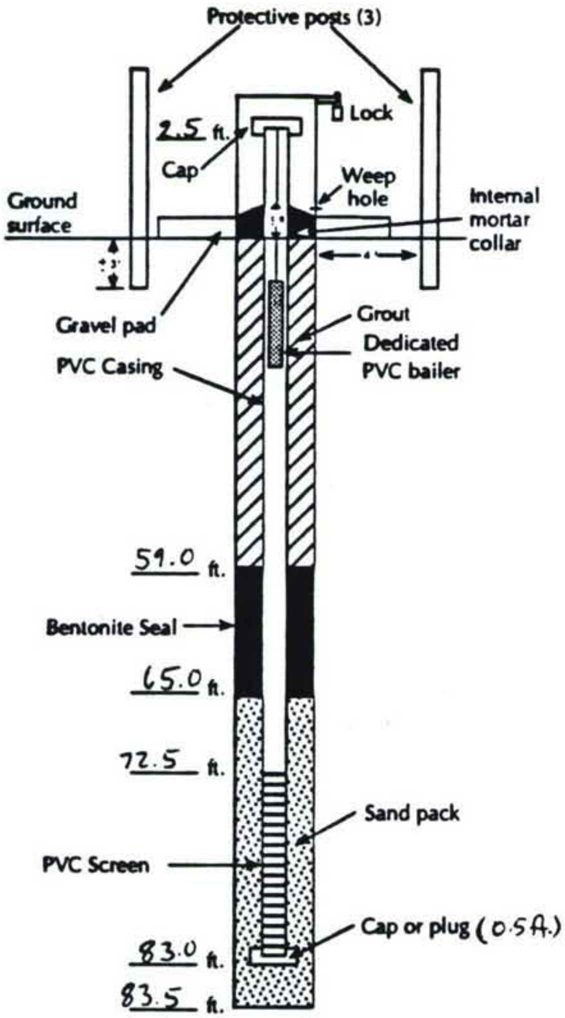
Well Construction Log

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs
SWMU No. between SWMUs 1 & 25
Field Geologist Conrad J. Bieniulis

Well No. S-97-92
Boring S-97-92
Installation Date 12-02-92
Checked by A. Warner 4/4/93



Not to scale

Measuring point is ground surface unless otherwise noted.

Drilling Summary

Total depth 83.5 ft.
Borehole diameter 8 (0'-29') 7 3/8 (29-TD) inches
Drilling company Boyles Bros.
Driller Dean Walton
Helper Jake Lawrence
Rig Schramm - air rotary B-57 - HSA
Method

- [x] Hollow stem auger 0'-19'
- [x] Air rotary 29'-83.5'
- [x] Air rotary/driven casing 0'-29'
- [ ] Mud rotary
- [ ] Other

Well Construction Materials

Grout
Quantity 8 sx. cmt. 1 sx. bent. powder
Type Mountain Cement Co. Type I-II L.A. Portland Cement (94 lbs. net ea.) Bentonite - pure bentonite powder - 50 lbs. ea.

Filter
No. ~~buckets~~ sx. 4 (100 lbs. ea.)
Sand type Colorado Silica Sand 10/20

Bentonite
Pellet size 1/4 inch
No. of buckets 2 (5 gals. ea.)
Type American Colloid Co. Volclay / Pure Gold 1/4"

Screen
Length [x] 10' [ ] 20'
I.D. [x] 4" [ ] 3.826"
Slot size .010
Type PVC
Schedule (casing) [x] 40 [ ] 80
Initial water level 69.0 ft (12-02-92)

Comments

Rev. 11/9/92

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2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

All Measurements From Top of Casing. DSD 12-04-92

Well Development Record

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs
Geologist: DePersis

Well No. S-97-92
Date of Installation 12-02-92

Well Information

Depth to water { 71.5 (Initially) / 71.15 (PreDevelopment) ft.
Casing stickup 2.5 ft.
Well depth 85.50 ft.
Screened interval 75.0 to 85.0* ft. WITH STIC
Casing diameter (ID) 4 in. to TD ft.
*Plug to 85.5 ft.
Amt. of fluid in well (Prior to development)
Borehole diameter 7 3/5 in. to Throughout screen + sandpack ft.
In well casing 9.35 gal.
Amt. of mud/water lost during drilling 0 (As per C. Bieniulus)
In sat. annulus 6.74 gal.
In (30% porosity) Sandpack under screen 1.11 gal.
~17.5 gal. per ~~in well~~ volume DSD 12-04-92
(1 Volume = 9.35 gal. + 6.74 gal + 1.11 gal + 0 gal = 17.2 ~ 17.5 gal)

Development

Date/time started 12-04-92 @ 1335
Completed 12-05-92 @ 1645

Water level
Before development 71.15 ft. (TOC)
24 hrs. after 70.98 ft. 12/12/92 MS

Depth to sediment
Before development 85.18 ft. (TOC)
After development 85.50 ft (TOC)

HyDAC Serial Number - 9209B DSD 12-04-92

Measurement	pH	μS Elec. Conduct. (~~mmhos~~/cm @ ~~°C~~ °F) Temp (~~°C~~)(°F) DSD 12-04-92	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	8.61	1,698 @ 59.1°F	12-04-92	1340	0 gal	Clear Water (even yet undisturbed sediment)
1	7.65	1,679 @ 55.1°F	12-04-92	1612	17.5 gal	Very Slightly Cloudy
↳ Stopped bailing for the night after a total of 28 gal. removed from well. DSD 12-04-92						
2	7.41	1,742 ~~@ 60.5°F~~	12-05-92	0930	35.0 gal	Slightly Cloudy
3	7.53	1,692 @ 60.5 ~~1431 @ 48.9°F~~ DSD 12-05-92	12-05-92	1139 ~~1134~~	52.5 gal	~~Has~~ Slightly Cloudy DSD 12-04-98
4	7.46	1,784 @ 57.2°F	12-05-92	1402 DSD 12-05-92	60.0 gal	Clear Mostly (Clearing.)
5	7.47	1,661 @ 59.1°F	12-05-92	1645	87.5 ~~77.1~~ DSD 12-05-92 gal	Mostly Clear to Slightly Cloudy
Extra purges	Well is developed after 87.5 gal removed - Stabilization of parameters is sufficient. DSD 12-05-92				gal	
After development					gal	

Surge technique No surge block used, however, some surging action w/ bailer.
Type, size and capacity of bailer or pump PVC Bailer - 3 inch (ID) x ~~10~~ 3 ft, ~~3.5~~ 1.1 gal. capacity. DSD 12-04-92
Quantity of fluid removed 87.5 gal.
Time for removal ~12 hours of intermittent bailing. DSD 12-04-92
Comments Approximately ~~0.35~~ 0.32 ft. of fine light brown sediment in well before bailing (minor amount relative to S-96-92 3-95-92) DSD 12-04-92
Well hand bailed dry in approximately 1/2 hour of continuous bailing.
Recovery is too slow to pump.

Note: all depths measured from top of casing

Rev. 11/9/92

ID - Inner Diameter
TD - Total Depth
gal. - gallon
ft. - foot
@ - at

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2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Notes

Field Bore Log

Site Type: Well
Site ID: S-98-92
Dia. of Hole: 7 3/8"
Date/Time Started: 11-19-92/1230
Date/Time Completed: 12-03-92/14:36
Surface Elevation:
Water Level: Initial (ft.): 36.5
Completion Depth (ft.): 41.0
Drilling Company: Boyles Bros.
No. Samples: 6-split spoon, 5-cuttings
Drilling Method: HSA / Air Rotary
Driller: J. Halec, D. Walton
Geologist/Date (Signature): Carol J. Breinidis
Checked by/Date: A. Warner 4/6/93

Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
0		cuttings					All cuttings are fines (clayey silt as below)
5		1 split spoon	4.0-6.0	4.0-6.0	1.5/2.0	ML	4.0-6.0 clayey SILT with trace caliche veins; 60% silt, 40% clay; 10YR 7/3 very pale brown; low to med. plasticity; stiff; dry
		cuttings					No major discontinuities noted
10		2 split spoon	9-11 ft	9-11 ft	1.0/2.0	ML	9-11 ft: Clayey SILT with trace caliche veins; 60% silt, 40% clay; 10YR 6/3 pale brown; low to med plasticity; v. stiff to hard; dry
		cuttings					No major Discontinuities noted, although appeared to soften at approx 113 ft
15		3 split spoon	14-16 ft	14-16 ft	1.5/2.0	ML	14-16 ft: clayey SILT with trace caliche veins; 65% silt, 35% clay; 5Y 7/2 light gray; low to med plasticity; v. stiff; dry
	Top of Bentonite seal = 17.2'						

Rev. 11/9/92

Field Bore Log S-98-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
16,20,31,40	20		SS #4	19-20.3	19-20.3	1.3/2.0	ML	19'-20.3' clayey SILT. 25% clay, 75% silt. Light brownish-gray (6/2 2.5Y). Occassional caliche nodules and plant fragments. Non-plastic, MST, MD, Dry to LM. 20.3-21' no recovery
	25	Top of Filter Pack = 23.3'	Cuttings	24-26	24-26	NA	CL	24'-26' silty CLAY. 20% silt, 80% clay. Light brownish-gray (6/2 2.5Y). Low plasticity, LM.
10,16,19,24	30	Top of Screen = 28.7'	SS #5	29-31	29-31	2.0/2.0	ML	29'-31' clayey SILT. 25% clay 75% silt. Light Olive Gray (6/2 5Y). Minor caliche nodules and plant fragments throughout. Non-plastic, MST, MD, Dry to LM.
	35		Cuttings	34-36	34-36	NA	CL	34'-36' silty CLAY. 20% silt, 80% clay. Light Olive Gray (6/2 5Y). Low plasticity, LM.
		Bottom of Screen = 38.7'						
12,16,25,19	40	Bottom of Sump = 39.2'	SS #6	39-41	39-41	2.0/2.0	ML	39'-41' clayey SILT. 30% clay, 70% silt. Light Gray (7/2 2.5Y). Minor iron staining interspersed. Non-plastic, MST, MD, Dry.
		TD = 41.0'						
	45							
	50							

Rev. 11/9/92 Boring terminated due to water encountered in boring and in 1/2 hour saw 3 ft. rise in water level. AW 4/6/93 from field notes

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Well Construction Log

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs

SWMU No. outside north perimeter of SWMU 25

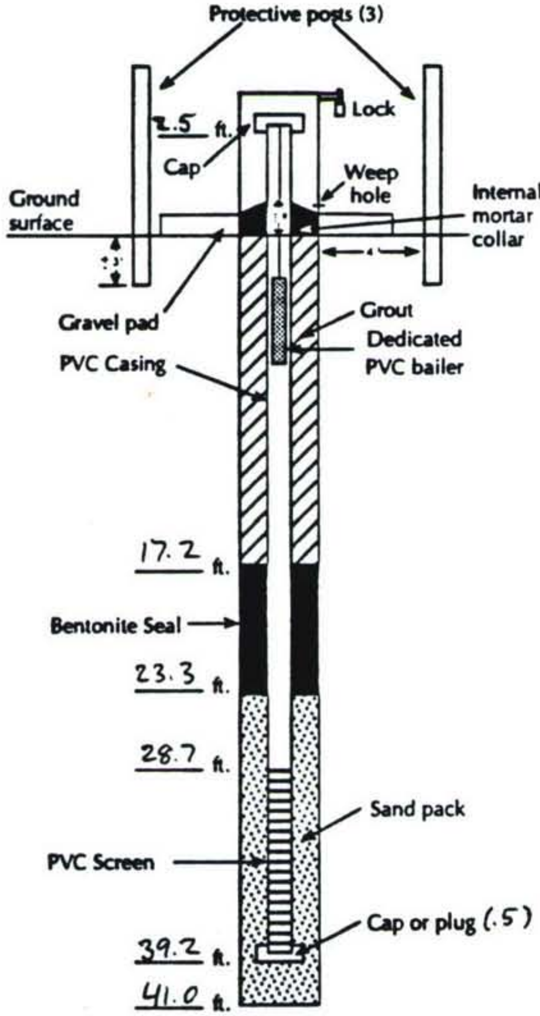
Field Geologist: Conrad J. Bieniulis

Well No. S-98-92

Boring: S-98-92

Installation Date: 12-03-92

Checked by: A. Viamer 4/6/93



Drilling Summary

Total depth: 41.0 ft.

Borehole diameter: 12"-HSA 7 7/8"-air inches

Drilling company: Boyles Bros.

Driller: Dean Walton

Helper: Jake Lawrence

Rig: Schramm - air rotary B-57 - HSA

Method

- ☑ Hollow stem auger 0'-16'
- ☑ Air rotary 18.5'-41.0'
- ☑ Air rotary/driven casing 0'-18.5'
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout

Quantity: 4 1/3 sx cmt 1/2 sx bent powder

Type: Cement - Mountain Cement Co - Portland Type I-II L.A. (low alkali) 94 lbs. ea. Bentonite - pure bentonite 50 lbs. ea.

Filter

No. ~~buckets~~ sx.: 2 2/3 (100 lb. ea.)

Sand type: Colorado Silica Sand 10/20

Bentonite

Pellet size: 1/4 inch

No. of buckets: 1 (50 lb. ea.)

Type: American Colloid Co Volclay / Pure Gold

Screen

Length: ☑ 10' ☐ 20'

I.D.: ☑ 4" ☐ 3.826"

Slot size: .010

Type: PVC

Schedule (casing): ☑ 40 ☐ 80

Initial water level: 36.5 ft. (12-03-92)

Comments

Not to scale

Measuring point is ground surface unless otherwise noted.

Rev. 11/9/92

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Well Development Record

Project **TEAD - South Area** **RFI - Phase II - Group 1 SWMUs** Geologist J. Ostergren

Well No. S-98-92 Date of Installation 12-3-92

Well Information

Depth to water 30.2 (pre-devel) ft. TOC Casing stickup 2.5 ft.
Well depth 39.2 (bottom of casing) 41.0 (TD of sand pack) ft. b.g.s. Screened interval 28.7 to 38.7* ft. bgs.
*39.2 = bottom of plug
Casing diameter 4 ID in. to 39.2 ft. bgs. Amt. of fluid in well (Prior to development)
Borehole diameter 7 3/4 in. to 41.0 ft. bgs. In well casing 7.5 gal
Amt. of mud/water lost during drilling Ø In sat. annulus (30% porosity) 7.5 gal (6.2 in cased section) (1.3 in overdrill/sump)

Development

Date/time started 12-6-92 / 1105 Completed 12-7-92 / 1120

Water level Depth to sediment
Before development 30.2 ft Before development 41.4
24 hrs. after 30.3' (11:35, 12-09) After development non-measurable

Measurement	pH	Elec. Conduct. (mmhos/cm @ ~~°C~~ °F) Temp(~~°C~~) °F	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	7.37	20,000+ (off scale) @ 59.0°F	12-6-92	1105	0 gal	clear, w/ v. lt cloudiness
1	7.40	20,000+ @ 55.0°F	12-6-92	1202	15 gal	lt. brownish gray, trace silt
2	7.37	20,000+ @ 57.9°F	12-6-92	1338	30 gal	cloudy v. lt gray, trace silt
3	7.36	20,000+ @ 53.9°F	12-6-92	1525	45 gal	cloudy v lt gray
4	7.52	20,000+ @ 52.9°F	12-7-92	0945	60 gal	cloudy v. lt. brownish gray
5	7.46	20,000+ @ 59.5°F	12-7-92	1120	75 gal	clear, w/ slight lt. gray cloudiness
Extra purges	NA				gal	
After development	See	measurement #5 above			gal	

Surge technique NA
Type, size and capacity of bailer or pump PVC 3inch ID x 36" (~1 gal/bail)
Quantity of fluid removed 75 gallons Time for removal ~24 hours intermittent bailing
Comments

Note: all depths measured from top of casing

Rev. 11/9/92

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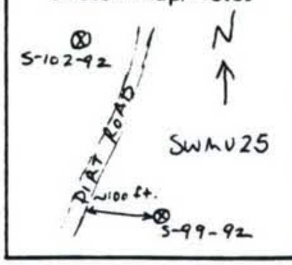
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Notes



Field Bore Log

Air Rotary Drilling: 16-40 ft. 7 3/8-inch
Auger Drilling: 0-16 ft.

Site Type: Well
Site ID: S-99-92
Dia. of Hole: 8 ~~7.0~~-inch AW 12-07-92
Date/Time Started: 12-06-92 @ 0822
Date/Time Completed: 12-07-92 ~1300
Surface Elevation:
Water Level: Initial (ft) ~32 ft. bgs
Completion Depth (ft.): 40 ft. bgs 16 AW
Drilling Company: Boyles Bros.
No. Samples: 6 spoons
Drilling Method: Hollow-Stem Auger to ~~14~~ ft. AW 4/6/93; Air Rotary from ~~14~~ 16 ft. to T.D. AW 4/6/93
Driller: Jay Hulse - Hollow Stem Rig; Dean Walton - Air Rig
Geologist/Date: E. DePersis / 12-06-92 (Signature) (Also — C. Bienulis)
Checked by/Date: A. Warner 4/6/93

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	0–4							Loose fine-grained cuttings. Similar to that below (4-6 ft. interval).
7/12/10/13	4–6		#1	4-6	4-6	1.45/2.0	ML	4-~~8~~6 ft. = SILT w/ some clay and trace fine sand. (20% clay, 75% silt, 5% fine sand). Very Pale Brown (10YR 7/3). Low plasticity. Med. consistency. Not cemented. Dry. DEO 12-06-92
	6–9							No changes evident in cuttings.
14/24/26/45	9–11		SS #2	9-11	9-11	1.75/2.0	ML	9-11 ft. = Clayey SILT w/ trace fine sand. (30% clay, 65% silt, 5% Fine Sand). Lt. brownish gray (10YR 6/2). Low to Med. plasticity. Stiff to Hard. Dry. Not Cemented.
	11–14		*Finish augering for the day @ ~~14~~ 16 ft. bgs. (Spoon driven to 16 ft.) AW 4/6/93 DEO 12-06-92; Begin drilling @ 16 ft. w/ Air Rig DEO 12-7-92					Driller notes harder drilling @ ~12.5 ft.
10/24/35/50* *For 4 in.	14–16		SS #3	14-16	14-16	1.70/2.0	ML	14-16 ft. = Clayey SILT (40% clay, 60% silt) Lt. br. gray (2.5Y 6/2). Med. plasticity. Hard to very Hard. Not cemented. Dry to little moisture. Small white calcite veinlets, and a's dark brown to black staining (minor) along some breakage surfaces. DEO 12-06-92
	16–19	Top of Seal @ 16.5 ft. bgs						*DePersis relinquishes bore log to Bienulis → DEO 12-06-92*

AUGER DRILLING TO 16 FT. ROTARY DRILLING AT 16 FEET — START AW 4/6/93

Rev. 11/9/92

SWMU = Solid Waste Management Unit; N = North; ft. = feet; in. = inches; SS = Split Spoon; # = Number; TD = Total depth; bgs = below ground surface

Field Bore Log S-99-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
10,25,29,35	20		SS #4	19'-21'	19'-21'	2.0/2.0	ML	19'-21' clayey SILT. 25% clay, 75% silt. Light brownish gray (2.5Y 6/2). MD, MST, Dry. Caliche and iron staining interspersed throughout. Non-plastic.
		▽ 12-07-92						
	25	Top of Filter Pack = 23.0'	Cuttings	24-26'	24'-26'	NA	ML	24'-26' sandy, gravelly SILT w/ trace clay. 15% Sand, 20% Gravels, 60% Silt, 5% Clay. Light brownish gray (10YR 6/2). Dry, Non-plastic
25,50	30	Top of Screen = 28'	SS #5	29'-30'	29'-30'	1.0/1.0	ML	29'-30' clayey SILT. 20% Clay, 80% Silt. Light yellowish brown (10YR 6/4). Med. to MST, Loose to MD, Dry, Non-plastic. Refusal at 30'. No recovery for 30'-31' interval.
	35		Cuttings	34'-36'	34'-36'	NA	ML	34'-36' clayey SILT. 20% Clay, 80% Silt. Light yellowish brown (10YR 6/4). Dry, Non-plastic.
		Bottom of Screen = 38'						
35,50	40	Bottom of End Cap: 38.5'	SS #6	39'-40'	39'-40'	1.0/1.0	CL	39'-40' silty CLAY. 30% Silt, 70% Clay. Pale Brown (10YR 6/3). Soft, MD, low to med. plasticity, moist. Refusal at 40'. No recovery for 40'-41' interval.
		TD = 40'						
	45							
	50							

Rev. 11/9/92 Water encountered during drilling at 39 feet, let boring set for ~2½ hours and level rose ~7 feet, decide to set well.

AW 4/6/93 from field notes

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Well Construction Log

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs

SWMU No. 25

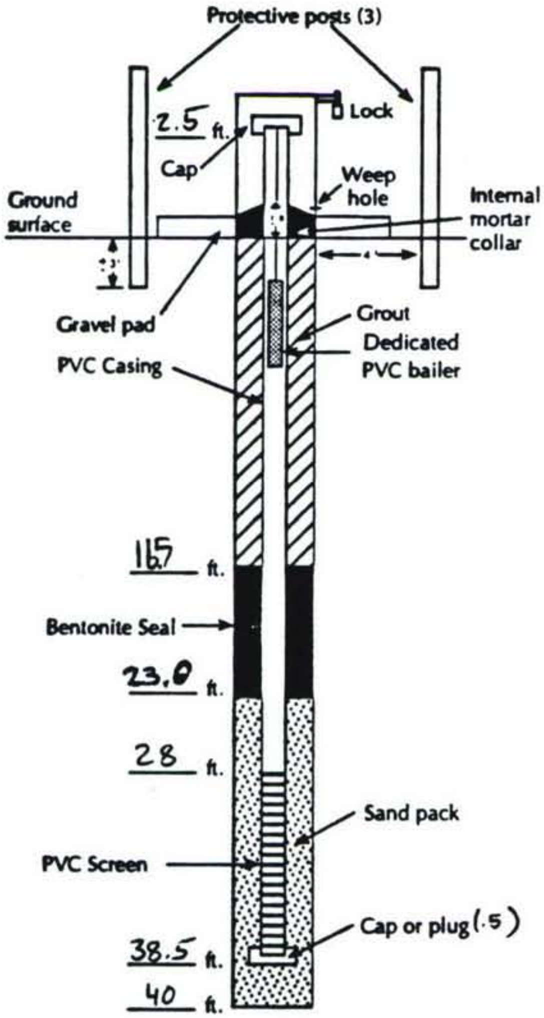
Field Geologist Conrad J. Bieniulis

Well No. S-99-92

Boring S-99-92

Installation Date 12-07-92

Checked by A. Warner 4/6/93



Drilling Summary

Total depth 40 ft.
Borehole diameter 8"-HSA 7 7/8"-air inches
Drilling company Boyles Bros.
Driller Dean Walton
Helper Jake Lawrence
Rig Schramm - air B-57 - HSA
Method

- ☑ Hollow stem auger 0'-16'
- ☑ Air rotary 16'-40'
- ☑ Air rotary/driven casing 0'-10'
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout
Quantity 3 sx. cmt. 1/4 sx. bent. powder
Type Cement: Mountain Cement Co. - Portland Type I-II L.A. (94 lbs. ea.)
Bentonite: pure bentonite powder (50 lbs. ea.)

Filter
No. ~~buckets~~ sx. 3 (100 lb. ea.)
Sand type Colorado Silica Sand 10/20

Bentonite
Pellet size 1/4 inch
No. of buckets 1.5 (50 lb. ea.)
Type American Colloid Co. Volclay/Pure Gold

Screen
Length ☑ 10' ☐ 20'
I.D. ☑ 4" ☐ 3.826"
Slot size .010
Type PVC
Schedule (casing) ☑ 40 ☐ 80
Initial water level 32 ft. (12-07-92)

Comments

Not to scale

Measuring point is ground surface unless otherwise noted.

Rev. 11/9/92

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Well Development Record

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs

Geologist J. Ostergren / C. Bieniulis

Well No. S-99-92

Date of Installation 12-7-92

Well Information

Depth to water 29.6 ft. (g.s.)

Casing stickup 2.3 ft.

Well depth 38.5 ft. (g.s.)

Screened interval 28.0 to 38.0 ft. g.s.

Casing diameter 4 in. to 38.5 ft.

Borehole diameter 7 7/8 in. to 40.0 ft.

Amt. of mud/water lost during drilling 0

Amt. of fluid in well (Prior to development)
In well casing 5.8 gal
In sat. annulus 5.2 gal
11.0 gal/vol
(30% porosity) (including overdrill sandpack)

Development

Date/time started 12-9-92 / 0935

Completed 12-10-92 / 1240

Water level
Before development ~~29.6~~ 31.9 Ft on 12/10/93 8:46
24 hrs. after 31.80 12/12/92

Depth to sediment
Before development non-measurable
After development Non-measurable

Measurement	pH	Elec. Conduct. (mmhos/cm @ °C Temp(°C)	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	7.61	19,100 @ 57.8°F	12-9-92	0935	0 gal	(transparent) v. slight cloudiness
1	7.55	19620 @ 56.6°F	12-9-92	1251	11 gal	(translucent) slight cloudiness
2	8.45	19940 @ 43.8°F	12-09-92	1338	11 gal	minor silt on bottom cloudy lt. grayish-brown
3	8.53	19,840 @ 47.8°F	12-09-92	1506	11 gal	minor silt on bottom cloudy lt. grayish-brown
4	7.02	19,760 @ 42.0°F	12-10-92	0906	11 gal	minor silt on bottom translucent v. lt. gray
5	7.01	19780 @ 49.1°F	12-10-92	1007	11 gal	v. minor silt on bottom translucent v. lt. gray
Extra purges	6.67	19890 @ 56.2°F	12-10-92	1240	11 gal	v. minor silt on bottom translucent, v. lt. gray
After development					gal	

Surge technique Bail down, let recover

Type, size and capacity of bailer or pump PVC bailer 3' x 3" I.D. ≈ 1.0 gal

Quantity of fluid removed 67 gal

Time for removal ~9 hours

Comments Total water removed during dvlpt. = 66 gal + 1 gal for final sample

Note: all depths measured from top of casing

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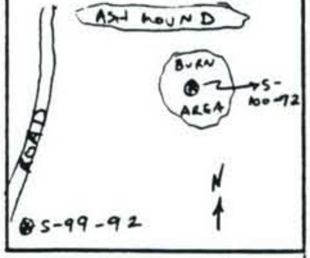
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Field Bore Log

Sketch Map/Notes



Site Type Well
Site ID S-100-92
Dia. of Hole 10-inch
Date/Time Started 12-06-92 @ 1207
Date/Time Completed 12-09-92 @ 1548
Surface Elevation
Water Level: Initial (ft.) 59.4 ft. bgs (water level in augers-morning after drilling to TD.)
Completion Depth (ft.) 74 ft. (74.7 actually slight overdrill)
Drilling Company Boyles Bros.
No. Samples 16 spoons
Drilling Method Hollow-Stem Auger
Driller Jay Hulse
Geologist/Date D.E. DePersis / 12-09-92 (Signature)
Checked by/Date A. Warner 4/6/93

Note: No geotechnical sampling conducted from 4-6 or 9-11 ft. split spoons, as not enough volume generated to fill chemical sample bottles and geotechnical sample bottles.

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	0–4							0-2/3 ft. = Dark gray, presumably burned material/debris. May have been heated significantly. Cuttings from below 2/3 ft. = Loose sandy cuttings w/ some fines. Cuttings fining w/ depth.
10/22/35/44	4–6		SS# 1	4-6 CS Tag #G1560	4-6	1.4/2.0	ML	4-6 ft. = Clayey SILT (25% clay, 75% silt) Pale brown (10YR 6/3). Low plasticity. Stiff to hand. Noncemented. Dry to little moisture
	6–9							
12/27/38/50* *For 3 in.	9–11		SS# 2	CS Tag #G1561 9-11	9-11	1.6/2.0	ML	9-11.0 ft. = Clayey SILT (30% clay, 65% silt) w/ trace gravel (5%). Med. plasticity. Stiff to Hard. Not cemented. Little moisture. Gravel is gray and subangular.
18/28/37/50* *For 2 in.	11–13		SS# 3	11-13	11-13	0.4/2.0	NA	11-13 ft. = No Recovery. Only ~ 0.4 inches of slough in core barrel. (Stiff material probably plugging end of core barrel.)
	13–14							
16/38/50/50* *For 4 in.	14–16		SS # 4	14-16	14-16	1.7/2.0	ML	14-16 ft. = Clayey SILT - same as above but slightly clayier. Med. plasticity, stiff to hand, Not cemented, little moisture. Mottled w/ some lighter coloring. Minor subangular dk. gry. gravel also. DED 12-12
	16–18		STOPPED AUGERING FOR THE DAY @ 14 ft. (Spoon driven to 16 ft.) DED 12-06-92 / Resume augering @ 14 ft DED 12-08-92					Cuttings appear browner and more moist than above.

Rev. 11/9/92

SS = Split Spoon
CS = Chemical Sample (for laboratory analysis)
ft = feet
NA = not applicable
w/ = with
W/ = with
in. = inches
# = number
~ = approximately
bgs = below ground surface

Field Bore Log

Well S-100-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
7/20/27/32	19, 20, 21		SS #5	19-21	19-21	2.0/2.0	ML	19-21 ft. = Clayey SILT (25% clay, 75% silt). Yel. Brown (10YR 5/6), Low to Med. Plasticity, Medium to Firm - fairly crumbly, some poorly cemented caliche rich zones and nodules, med. moist to ~~and~~ little moist. (dryer + lighter colored at depth). Some lighter colored mottling also. — DEA 12/08/92
	22, 23							Cuttings appear siltier.
15/40/50* *for 5½ in.	24, 25, 26		SS #6	24-26	24-26	1.6/2.0	ML	24-26 ft. = Similar to above. (Upon closer inspection, nodules described above are probably closer to moderately cemented.)
	27, 28							Driller notes softer drilling @ ~33 ft. No dramatic change observed in cuttings.
9/20/27/42	29, 30, 31		SS #7	29-31	29-31	2.0/2.0	ML	29-31 ft. = Similar to above. Cemented presumably calcite, rich material occurs in thin zones between siltier material. Bottom 1/3 foot of sample is moist.
	32, 33							No change observed in cuttings.
7/17/27/50* for 5 in.	34, 35, 36		SS #8	34-36	34-36	2.0/2.0	ML	34-36 ft. = Clayey silt. (33% clay, 67% silt). Clayier than overlying material described above. Yel. brown (10YR 5/4) - slightly darker than above. Minor caliche. Low to Med. plasticity, soft to medium, not cemented, moist (moister than above)
	37, 38							Cuttings are fine-grained and ~~very~~ moist to very moist. ~~Wet~~ DEA 120892 Driller notes increased ease of drilling at 37 ft.
30/50* 7/14/~~17~~/40 *for 4 in.	39, 40, 41		SS #9	39-41 ft.	39-41 ft.	2.0/2.0	ML	39-41 ft. = Similar to above. Slightly clayier, however (35% clay, 65% silt).
	42, 43							Drilling becomes very hard (for the first time at this location) @ 41 ft. Drilling softens slightly @ ~43 ft. - easier to drill. Cuttings are very moist ~~to wetter~~ or wetter (than very moist).
7/14/17/40	44, 45, 46		SS #10	44-46	44-46	2.0/2.0	ML	44-46 ft. = Siltier than 39-41 ft. interval (30% clay, 70% silt). Sample is slightly wetter also.
	47, 48		(Pulled augers and waited for water (augers lifted 5 ft. off bottom of hole) → NO WATER DOWNHOLE - Proceed w/ drilling. DEA 12-08-92					Cuttings moistening + softening.
	49	Top of Seal @ 49.0 ft. bgs.						49-51 ft. = This interval logged on the following page - page #3.

Rev. 11/9/92

SS = split spoon
w/ = with
= number

ft. = feet
in. = inches
@ = at
~ = approximately

bgs = below ground surface.

Field Bore Log

Well 5-100-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
8/13/30/40	49–51		SS# 11	49-51 ft.	49-51 ft.	2.0/2.0	ML	49-51 ft. = Same as above (44-46 ft.). (No water downhole - end of bit, etc.)
	51–54							Cuttings appear same as those @ 46-49 ft.
12/24/50* *For 5½ in.	54–56	Top of Sand-pack @ 54.0 ft. bgs.	SS# 12	54-56 ft.	54-56 ft.	2.0/2.0	ML	54-56 ft. = Same as above material described in 44-46 ft. interval.
	56–59	9:10 12-08 → Stopped for the day after augering to 59 ft and driving spoon to 61 ft. bgs. DEP 12/08/92						No distinct changes noted in composition or moisture content of cuttings. DEP 12-08-92: Stopped augering for the day @ 59 ft.
9/18/22/26	59–61	Top of Screen @ 59.3 ft. bgs.	SS# 13	59-61 ft.	59-61 ft.	2.0/2.0	ML	59-61 ft. = Top 1/4 ft (to 59.25) is Pal. Br. (10YR6/3). This zone is locally silty. Sample throughout remaining portion is lt. yel. brown (10YR6/4) w/ short zones of lighter mottling (very pale brown -10YR 8/2). Less silty than first 1/4 ft. All still clayey SILT. DEP 12-08-92
	61–64							No changes noted in cuttings.
12/27/47/50* *For 5 in.	64–66		SS# 14	64-66	64-66	2.0/2.0	ML ML	64-65 ft. = clayey silt (28% clay, 72% silt). Very low plasticity (2.5YR 6/3) lt. yel. brown, firm, not cemented, moist. 65-66 ft. = clayey silt (clay ≈35%, silt ≈65%) clayier than above, low plasticity, not cemented, hard to very hard, moist, lt. yel. br (2.5 YR)
	66–69							Balls of clayey soil coming up out of hole. Drilling is still hard (very hard) to ~~67 ft.~~ 66 ft. AEO 12-09-92 Drilling is significantly easier after ~~64~~ 66 ft. AEO 12-09-92 Cuttings coming up saturate after hard material broken through. Therefore water at 66 ft. based on field observation.
10/17/25/50* *For 4 in.	69–71		SS# 15	69 71	69-71	2.0/2.0	ML	* 69-71 ft. = clayey silt (25% clay, 75% silt) low plasticity. Not cemented. Medium - crumbles easily, moist. (5Y 6/2) Light olive gray.

* Attempted to sample water bearing material with ~~64~~ AEO 12-09-92 69-71 ft sample collected above; however, softer drilling (which presumably occurred in water bearing material) extended from 66 ft to ~67.5 ft. only, therefore presumably only 1.5 ft. of water bearing material present, therefore this sample probably does not represent water bearing material.

Rev. 11/9/92

SS = split spoon
W/ = with
= number

ft. = feet
in. = inches
@ = at
~ = approximately

bgs = below ground surface

Field Bore Log

Well S-100-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
								Light brown clayey material on tip of center bit pulled from hole after augering to 72 ft.
	72							
8/25/34/50*	73		SS #16	72-74	72-74	2.0/2.0	CL	72-74 ft. = Silty CLAY. (60% clay, 40% silt). Very Pale Brown (10YR 8/2) (Looks "white"). Med to High plasticity. Stiff to very stiff. Not cemented. Dry to little moisture - breaks apart easily. (upper 1/4 ft. is slightly drier than above - also harder and slightly darker in color.
*for 5½ in.	74	Bottom of Screen / PLUG	74.3 ft bgs / T.D. = 74.7 ft bgs					

STOP DRILLING FOR THE DAY - AUGERS @ 74 ft. DSD 12-09-92

12-10-92 @ 0802 - Depth to water downhole = 59.4 ft. bgs. (sufficient water to set a well ∴ no additional drilling)

T.D. = 74.7 ft. (Slight overdrill due to teeth of lead auger extending forward.) DED 12-10-92

~~SS - Split spoon~~ DED 12-10-92

NOTE

Water bearing zone is probably above silty clay described in the 72-74 ft. interval, not the 66 to 67.5 ft. zone described earlier. DED 12-09-92

Rev. 11/9/92 SS = split spoon # = number in. = inches ft. = feet TD = Total Depth bgs = Below Ground Surface

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Construction Log

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs

Well No. S-100-92

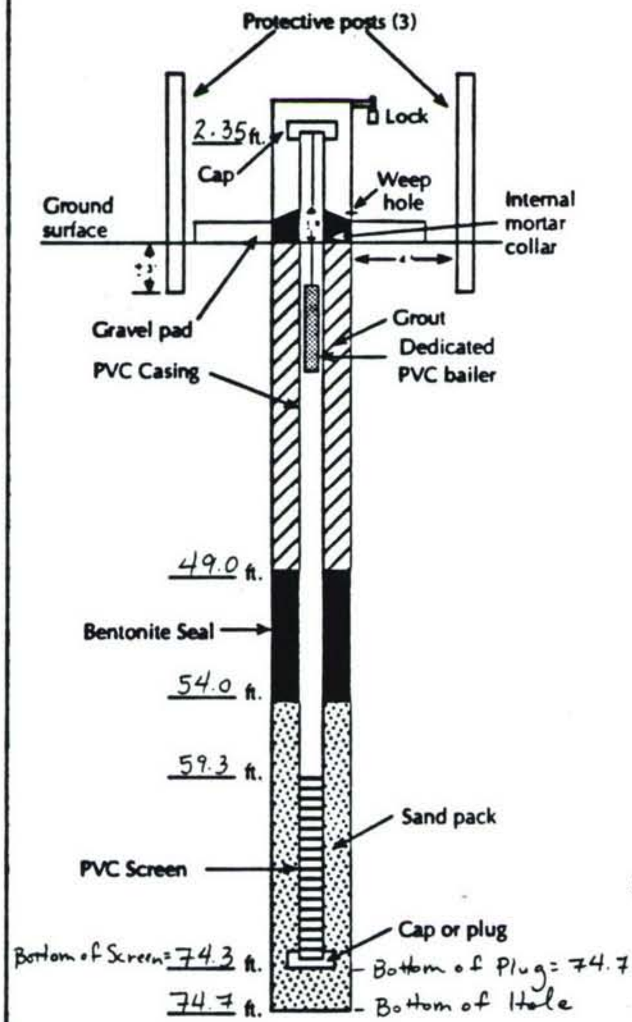
SWMU No. 25

Boring S-100-92

Field Geologist DePersis

Installation Date 12-10-92

Checked by A. Warner 4/6/93



Drilling Summary

Total depth 74.7 ft.

Borehole diameter 10 inches

Drilling company **Boyles Bros.**

Driller Jay Hulse

Helper Troy Wood

Rig Mobil B57 Rig

Method

- ☒ Hollow stem auger
- ☐ Air rotary
- ☐ Air rotary/driven casing
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout

Quantity 14 bags cement @ 94 lb/bag + 2 bags Powdered bentonite @ 50 lb bag

Type Mountain Cement Co. Type I-II-LA Portland Cement w/ some powdered bentonite (8:1 ratio).

Filter

No. ~~buckets~~ bags DJD 12-10-92 7 1/2 @ 100 lb/bag

Sand type **Colorado Silica Sand 10/20**

Bentonite

Pellet size **1/4 inch**

No. of buckets 3 1/2 @ 50 lb/bucket

Type Acc Volclay 1/4-inch pellets

Screen

Length ☐ 10' ☒ 15' ☐ 20'

I.D. ☒ 4" ☐ 3.826"

Slot size .010

Type PVC

Schedule (casing) ☒ 40 ☐ 80

Initial water level 59.4 ft (bgs) = Depth to water in augers before setting well.

Comments

Bottom of 0.4 ft. long plug on bottom of hole. No water added to hole during drilling or installation.

Not to scale

Measuring point is ground surface unless otherwise noted.

bgs = below ground surface
lb = pound co = company

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Development Record

Project: TEAD - South Area, RFI - Phase II - Group 1 SWMUs
Geologist: DePersis / Ostergren

Well No.: S-100-92
Date of Installation: 12-10-92

Well Information

* ALL MEASUREMENTS FROM TOC. * DMO 12-13-92

Water measured in augers prior to installing well.

Depth to water: 61.9 (59.4 ft bgs + 2.5 ft) ft.
Casing stickup: 2.5 (Measured on-site) ft.
Well depth: 77.2 ft.
Screened interval: 76.8 ft. to 61.8 ft. includes stickup; 74.3 ft to 59.3 ft bgs
Casing diameter (ID): 4 in. to TD ft.
Amt. of fluid in well (Prior to development)
Borehole diameter: 10 in. to TD ft.
In well casing: ~~18.30 gal.~~ 11.62 gal. DMO 12-13-92
Amt. of mud/water lost during drilling: None (0).
In sat. annulus (30% porosity): ~~29.92 gal.~~ 18.30 gal.

1 volume = 11.62 gal. + 18.30 gal. = 29.92 gal. ~30 gal. volume

Development

Date/time started: 12-13-92 @ 1043
Completed: 12-17-92 @ 0910

Water level
Before development: 59.2 ft (TOC)
24 hrs. after: 53.5 ft (TOC)

Depth to sediment
Before development: 77.0 ft. (No sediment on weight from tape when removing from well.)
After development: non-measurable

Measurement	pH	Elec. Conduct. µS/cm ~~(mmhos/cm @ °C)~~ @ °F; Temp (~~°C~~) °F DMO 12-13-92	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	8.31	4300 @ 55.1°F	12-13-92	1045	0 gal	Clear (Sample from top of water column.)
1	7.82	4170 @ 59.3°F	12-13-92	1135	30 gal	Pale Brown, Very Cloudy (Fine sand coming up on outside of bailer.)
	stopped bailing for the day after removing 40 gal. total. DMO 12-13-92					
2	7.80	4280 @ 57.2°F	12-15-92	0950	60 gal	pale brown, opaque
	stopped bailing for the day after removing 82 gal. total DMO 12-15-92					
3	8.14	4680 @ 48.0°F	12-16-92	0925	90 gal	pale brown, opaque
4	8.06	4180 @ 54.9°F	12-16-92	1610	120 gal	pale brown, opaque
5	7.86	4290 @ 56.0°F	12-17-92	0910	150 gal	pale brown, opaque
Extra purges					gal	
After development					gal	

Surge technique: No surge block, etc. used, however, some surging action produced by bailing.

Type, size and capacity of bailer or pump: PVC Bailer - 3-inch ID X 3 ft (~1.1 gal. capacity).

Quantity of fluid removed: 150 gallons
Time for removal: 3 days + 22 hrs 25 min

Comments: Recovery rate measured after bailing well dry for the first time. Very slow recovery (~18 1/4 min. per foot over ~~two~~ DMO 12-17-92 lowermost portion of screen) therefore well will be developed by periodic intervals of continuous bailing separated by longer intervals of waiting for recovery.

Note: all depths measured from top of casing

Rev. 11/9/92

PVC - polyvinylchloride
ID - Inner Diameter
TOC - Top of Casing
gal. = gallons
ft = feet
in = inches
bgs = below ground surface

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

Sketch Map/Notes

Field Bore Log

Site Type: Well
Site ID: S-101-92
Dia. of Hole: 7 3/8"
Date/Time Started: 12-04-92 1334
Date/Time Completed: 12-06-92 / 1115
Surface Elevation:
Water Level: Initial (ft.): 43.0
Completion Depth (ft.): 52.0
Drilling Company: Boyles Bros.
No. Samples: split spoon - 7, cuttings - 4
Drilling Method: Air Rotary
Driller: D. Walton
Geologist/Date: Conrad J. Brinidis (Signature)
Checked by/Date: A. Warner 4/6/93

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	0		Cuttings	0'-4'	0'-4'	NA	GP	0'-4' Gray limestone GRAVELS & PEBBLES. Zone of metal debris reported by UXB ~ 3' down. No samples collected for this interval.
50,13,19,15	5		SS #1	4'-5' 5'-6'	4'-5' 5'-6'	2.0/2.0	GP ML	4'-5' silty, sandy GRAVELS & PEBBLES. 20% silt, 30% v. fine to v. coarse sand, 50% pebbles and gravels. Lt. gray to black (10YR 7/1 to 10YR 2/1), max. length 1", mostly .3" to .5". V. loose, Dry. 5'-6' clayey SILT w/ trace sand. 20% clay, 75% silt, 5% v. fine sand. Yellowish brown (10YR 5/4). Interspersed caliche patches. Non-plastic, loose to MD, MST, Dry.
11,12,13,13			SS #2	8'-10'	8'-10'	2.0/2.0	ML	8'-10' v. fine to med. sandy SILT w/ tr. clay. 30% sand, 60% silt, 10% clay. Few pebbles in first 2". Caliche zones interspersed. Brown (10YR 5/3). Non-plastic, loose, med. consis., dry.
	10							
14,18,20,24			SS #3	12'-14'	12'-14'	2.0/2.0	ML	12'-14' clayey SILT w/ trace fine sand. 20% clay, 70% silt, 10% sand. Some caliche patches. Lt. yellowish brown (10YR 6/4). Med. consis, MD, Dry, non-plastic.
	15							
25,35,35,45			SS #4	16'-18'	16'-18'	2.0/2.0	ML	16'-18' clayey SILT w/ some fine sand, gravels, & pebbles. 20% clay, 65% silt, 15% sand, gravels, & pebbles. Some interspersed caliche and limestone pebbly zones. Lt. olive gray (5Y 6/2) to lt. brownish gray (10YR 6/2). MST, MD, Dry. non-plastic.

Field Bore Log S-101-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval	Description Interval	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	20							
	25		Cuttings	24'-26'	24'-26'	NA	ML	24'-26' clayey SILT. 35% clay 65% silt. Brown (10YR 5/3). non to low plasticity, dry.
7,15,30,45	30	Top of Seal = 29'	SS #5	29'-31'	29'-31'	2.0/2.0	ML	29'-31' clayey SILT. 20% clay, 80% silt. Light Gray (10YR 7/1). Loose, soft, dry.
	35	Top of Filter Pack = 34'	Cuttings	34'-36'	34'-36'	NA	ML	34'-36' clayey SILT. 30% clay, 70% silt. Pale Brown (10YR 6/3). Non- to low plasticity, dry.
10,15,20,25	40	Top of Screen = 40'	SS #6	39'-41'	39'-41'	2.0/2.0	ML	39'-41' clayey SILT. 20% clay, 80% silt. Light brownish-gray (2.5Y 6/2). Med. consis., MD, dry.
	45		Cuttings	44'-46'	44'-46'	NA	ML	44'-46' clayey SILT. 30% clay, 70% silt. Light yellowish brown (10YR 6/4). Non-plastic, dry.
25,50	50	Bottom of Screen = 50' Bottom of	SS #7	49'-50'	49'-50'	1.0/2.0	ML	49'-50' clayey SILT. 35% clay, 65% silt. Yellowish brown (5/4 10YR). MST, MD, dry. Caliche veins. Slough in 1st foot of split spoon.

Rev. 11/9/92 End Cap = 50.5'

Total Depth at 52' after reaming out hole on 12-05 and 12-06.
BORING TERMINATED AND WELL SET AFTER OBSERVING ~7 FEET OF H_2O IN 45 MINUTES.

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Construction Log

Project TEAD - South Area RFI - Phase II - Group 1 SWMUs

SWMU No. 25

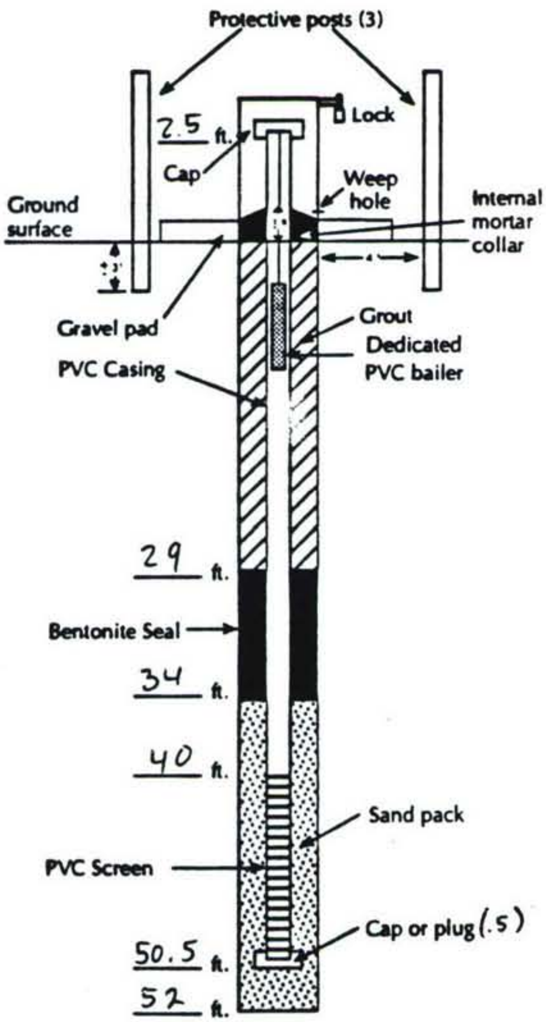
Field Geologist Conrad J. Bieniulis

Well No. S-101-92

Boring S-101-92

Installation Date 12-06-92

Checked by A. Werner 4/6/93



Drilling Summary

Total depth 52 ft.

Borehole diameter 7 3/8 inches

Drilling company **Boyles Bros.**

Driller Dean Walton

Helper Jake Lawrence

Rig Schramm

Method

- ☐ Hollow stem auger
- ☑ Air rotary 10' - 52'
- ☑ Air rotary/driven casing 0' - 10'
- ☐ Mud rotary
- ☐ Other

Well Construction Materials

Grout

Quantity 3 sx cmt ; .5 sx bent. powder

Type Cement: Mountain Cement Co. - Portland Type I-II L.A. (94 lbs ea.)
Bentonite: pure bentonite powder (50 lbs. ea.)

Filter

No. ~~buckets~~ sx 3 (100 lb ea.)

Sand type **Colorado Silica Sand 10/20**

Bentonite

Pellet size **1/4 inch**

No. of buckets 1.5 (50 lb. ea.)

Type American Colloid Co. Volclay/Pure Gold

Screen

Length ☑ 10' ☐ 20'

I.D. ☑ 4" ☐ 3.826"

Slot size **.010**

Type **PVC**

Schedule (casing) ☑ 40 ☐ 80

Initial water level 43 ft. (12-05-92)

Comments

Not to scale

Measuring point is ground surface unless otherwise noted.

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Well Development Record

Project **TEAD - South Area RFI - Phase II - Group 1 SWMUs**

Geologist J. OSTERGREN

Well No. S-101-92

Date of Installation 12-~~16~~-92 8 [illegible] 7/29/93 STIET

Well Information

Depth to water 41.85 ft. TOC 43.0 (from g.s. initially (12-5-92))

Well depth 52.9 ft. TOC

Casing diameter 4 in. to 50.5 ft. g.s.

Borehole diameter 7 3/8 in. to 52.0 ft.

Amt. of mud/water lost during drilling NONE

Casing stickup 2.4 ft.

Screened interval 40.0 to 50.0 ft. g.s.

Amt. of fluid in well (Prior to development)
In well casing 7.21 gal
In sat. annulus (30% porosity) 6.18 gal
13.4 gal/vol
[0.99 gal = overdrill sandpack below screen]
[5.19 gal = sandpack annulus]

Development

Date/time started 12-8-92 / ~~0802~~ 0829 AW 9/6/93

Completed 12-8-92 / 1439

Water level
Before development 41.85 ft
24 hrs. after 41.95 (1525 12-09-92)

Depth to sediment
Before development non-measurable
After development Non-Measurable

Measurement	pH	Elec. Conduct. (mmhos/cm @ °C) Temp(°C)	Date	Time	Vol. Wtr. Removed	Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	8.11	18950 @ 60.0°F	12-8-92	0853	0 gal	clear
1	7.80	20000+ @ 46.7°F	12-8-92	0956	13.5 gal	lt. brownish gray; [illegible] 300
2	7.61	19390 @ 55.5°F	12-8-92	1103	27.0 gal	lt. ~~brownish~~ grayish brown 300
3	7.58	~~[illegible]~~ 18730 @ 62.5°F	12-8-92	1202	40.5 gal	lt grayish brown; [illegible]
4	7.52	20000+ @ 53.2°F	12-8-92	1325	54.0 gal	lt brownish gray
5	7.62	20000+ @ 56.7°F	12-8-92	1439	67.5 gal	"
Extra purges					gal	
After development					gal	

Surge technique Bail down, let recover

Type, size and capacity of bailer or pump 3' x 3.5" O.D., ~1 gal.

Quantity of fluid removed 67.5 gals.

Time for removal

Comments "g.s." denotes measurement from ground surface.

Note: all depths measured from top of casing

Rev. 11/9/92

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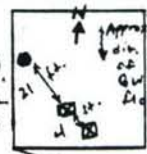
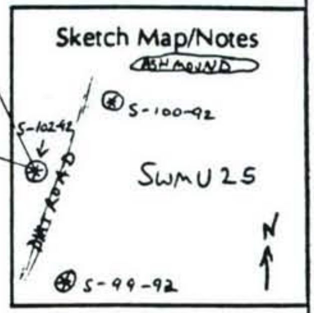
Tooele Army Depot - South Area, RFI - Phase II - Group 1 SWMUs

● = S-102-92
⊠ = Abandoned attempts (4 ft. bgs). offset during UXB clearance



DED 12-07-92

Sketch Map/Notes



Field Bore Log

Site Type Well
Site ID S-102-92 Dia. of Hole 10-inch
Date/Time Started 12-06-92 @ 1535
Date/Time Completed 12-07-92 @ 1230
Surface Elevation
Water Level: Initial (ft.) 35.2 ft. bgs. (Downhole water level in augers prior to installing well. DED 12-07-92)
Completion Depth (ft.) 44.0 ft. w/ augers
Drilling Company Boyles Bros.
No. Samples 9 spoons
Drilling Method Hollow-stem auger
Driller Jay Hulse
Geologist/Date D.E. DePersia 12/07/92 (Signature)
Checked by/Date A. Warner 4/6/93

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	0–3							Cuttings from 0-4 ft. = Brown soil w/ trace gravels - fining w/ depth.
28/23/32/35	4–6		SS # 1	4-6	4-6	1.7/2.0	ML	4-6 ft. = SILT w/ some clay, some f-c sand, and trace f-c gravel. (20% clay, 48% silt, 20% sand, 12% gravel). lt. br. gray (~~10YR~~ 2.5Y 6/2) to lt. ol. brown (~~10YR~~ 2.5Y 5/3). Low plasticity. Stiff. Not cemented. Little moisture. Caliche veinlets - white. Gravel is subrounded.
	7–8		Stopped drilling for the day @ 9 ft. bgs. DED 12-06-92					
	9		Resumed drilling for the day @ 9 ft. bgs. DED 12-07-92					
12/24/34/32	9–11		SS # 2	9-11	9-11	1.95/2.0	ML	9-11 ft. = clayey SILT (25% clay and 75% silt). (lt. br. gr. (10YR 6/2)) DED 12-07-92 Low plasticity. Firm to stiff. Not cemented. Little moisture. Minor caliche stringers present, as is minor orange iron staining
	12–13							clay content appears to be increasing w/ depth. DED 12-08-92
18/24/38/36	14–16		SS # 3	14-16	14-16	1.85/2.0	ML	14-16 ft. = Clayey SILT (30% clay, 70% silt). Pale Brown (10YR 6/3). Low to medium plasticity, Very stiff to hard, Not cemented, Little to medium moisture. Clay content increasing w/ depth throughout sample. Minor caliche present. Small patches of orange iron staining throughout. Very minor black staining along breakage surfaces also. DED 12-07-92
	17–18							Cuttings appear to moisten and increase in clay content.

Rev. 11/9/92

SWMU = Solid Waste Management Unit
N = North
SS = Split Spoon
Approx. = approximate
# = Number
ft. = foot
in = inch
dir. = direction
w/ = with
bgs = below ground surface
GW = groundwater

Field Bore Log

Well S-102-92

Blow Counts	Depth (ft)	Well Construction	Sample Type and Number	Sample Interval (ft.)	Description Interval (ft.)	Recovery (ft./ft.)	USCS Abbreviation	Description Soil Classification (Color, Texture, Structures, Moisture, Consistency, Comments)
	19							
24/45/50* * For 3 in.	20, 21		SS #4	19-21	19-21	1.35/2.0	ML	19-21 ft. = Same as above (14-16 ft interval) although locally siltier zones present throughout sample. Caliche content increases @~20.5 ft also.
	22, 23	Top of Seal @ 23 ft. bgs						Small balls of "clay" coming up augers (Relatively clayey material compared to cuttings @16-19 ft.) Driller notes that drilling hardens slightly @~23 ft.
48/50* * For 2½ in.	24, 25, 26		SS #5	24-26	24-26	0.9**/2.0	ML	24-26 ft. = Clayey SILT (25% ~~silt~~ clay, 70 ~~75~~% silt) w/ trace fine sand (5% fine sand). (Siltier than above.) Yel. brown (10YR 5/4). Low plasticity. Med. to Med. stiff. Not cemented, Med. moist. Small caliche stringers throughout
	27, 28	Top of Sand @ 28 ft. bgs				** Stiffer material (hard to drive spoon through) probably plugging core barrel.		Cutting appear to coarsen slightly w/ depth.
30/50* * For 3 in.	29, 30, 31		SS #6	29-31	29-31	0.85/2.0	ML	29-31 ft. = ~~Clayey~~ SILT w/ trace fine sand and some clay. (clay = 20%, silt = 70%, fine sand = 10%). More sand than above. Low to Med. plasticity. Med. consistency - crumbles ... hard to drive spoon. Lt. yel. brown (10YR 6/4). N... Med. moist. (Siltier zones present throughout core separated by thinner clayier zones.)
	32, 33	Top of Screen @ ~33.5 ft bgs						No obvious changes observed in cuttings.
22/49/50* * For 3 in.	34, 35, 36		SS #7	34-36	34-36	NR/2.0	ML	34-36 ft. = Same alternating siltier/clayier sequence as that described above (29-31 ft.), however, siltier zones in this interval are slightly coarser and more moist than above.
	37, 38							Driller notes ~~cuttings~~ drilling softens at 38.5 ft. (Probably water bearing material at this depth, therefore.)
24/48/50* * For 5½ in.	39, 40, 41		SS #8	39-41	39-41	1.33/2.0	ML	39-41 ft. = Clayey SILT (clay = 35%, silt = 65%). Pale brown (10YR 6/3). Med. to High plasticity. Not cemented. Very moist, Medium consistency. White pockets of material present also - may be caliche, but comprised of relatively coarse xtalline matter.
	42, 43	Bottom of Screen @~43.5 ft bgs						No changes observed in cuttings.
10/26/42/50* * For 3 in.	44, 45, 46	PLUG TD w/ augers @ 44 ft bgs	SS 9#	44-46	44-46	NR/2.0	ML	44-46 ft. = Clayey SILT (clay = 30%, silt = 70%) Lt. br. gray (2.5Y 6/2). Medium consistency. Not cemented. Very moist. Med. ~~to High~~ Plasticity.
	47, 48, 49	T.D. w/ spoon @ 46 ft. bgs						T.D. w/ augers = 44 ft. (Spoon driven to 46 ft, however.) Water encountered during drilling @ ~38.5 ft, let well set open for approximately ½ hour and level @ 35.2 ft. Thus stop drilling and set well.

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SS = Split Spoon
# = Number
NR = Not Recorded
TD = Total Depth
w/ = with
Xtalline = ~~chr~~ crystalline
ft. = feet
in. = inches
bgs = below ground surface

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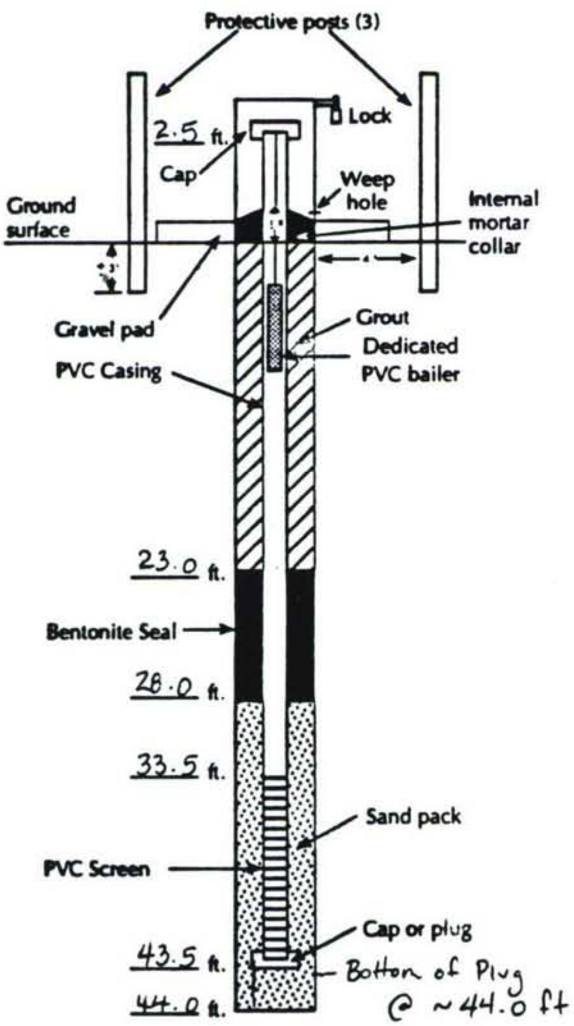
Well Construction Log

Project: TEAD - South Area RFI - Phase II - Group 1 SWMUs
SWMU No. 25
Field Geologist DePersis

Well No. S-102-92
Boring S-102-92
Installation Date 12-07-92
Checked by A. Warner 4/6/93



Drilling Summary

Total depth 44 ft. w/ augers.
Borehole diameter 10 inches
Drilling company **Boyles Bros.**
Driller Jay Hulse
Helper Troy Wood
Rig Mobil B-57 Auger Rig
Method
- [x] Hollow stem auger
- [ ] Air rotary
- [ ] Air rotary/driven casing
- [ ] Mud rotary
- [ ] Other

Well Construction Materials

Grout
- Quantity 7 bags cement / 1 bag powdered bentonite.
- Type Cement is Type I-II LA Portland Cement (Mountain Cement)

Filter
- No. ~~buckets~~ bags DCA 120792 7 1/2
- Sand type **Colorado Silica Sand 10/20**

Bentonite
- Pellet size **1/4 inch**
- No. of buckets 3 1/2
- Type ACC Volclay Pure Gold Tablets

Screen
- Length [x] 10' [ ] 20'
- I.D. [x] 4" [ ] 3.826"
- Slot size .010
- Type PVC
- Schedule (casing) [x] 40 [ ] 80
- Initial water level 35.2 ft.

Comments
No Water Added To Hole During Drilling Or Installation.

Not to scale

Measuring point is ground surface unless otherwise noted.

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Well Development Record

Project: **TEAD - South Area RFI - Phase II - Group 1 SWMUs**
Geologist: S. CONDRAN

Well No.: S-102-92
Date of Installation: 12-07-92

Well Information

Depth to water: 35.2 (initial) ft. G.S.
Casing stickup: 2.5 ft.
Well depth: 44.0 ft. G.S.
Screened interval: 33.5 to 43.5 ft. G.S.
Casing diameter: 4 in. to 0.33 ft.
Borehole diameter: 10 in. to ~~0/83~~ ft. SC 12/07/92
Amt. of mud/water lost during drilling: None

$V = (\pi R^2 h - \pi r^2 h).3 + \pi r^2 h$ h = 10.12'

Amt. of fluid in well (Prior to development)
In well casing: 6.60
In sat. annulus (30% porosity): 10.40
TOTAL 17.0 gals/vol.

Development

Date/time started: 12/10/92 / 1510
Completed: 12/10/92 / 1623

Water level
Before development: 36.33 ft
24 hrs. after: 36.28 ft 12/12/92

Depth to sediment
Before development: 46.45 ft.
After development: Not measurable

Measurement	TEMP	pH	Elec. µS/cm Conduct. ~~(mmhos/cm~~ @ °C SC 12/10/92 Temp(°C)	Date	Time	Vol. Wtr. Removed (gal)		Physical Characteristics (Clarity, odor, sand content, color, etc.)
Initial	57.4	6.28	20,000 +	12/10/92	1510	0	gal	Gray, cloudy
1	55.3	6.11	19,600	12/10/92	1520	17	gal	lt. brown, ~~silty~~ cloudy SC 12/10/92
2	1534 check well recovery ~~52.0~~	6.14	20,000 +	12/10/92	1547	34	gal	"
3	~~56.3~~	6.11	20,000 +	12/10/92	1559	51	gal	lt. brown, cloudy
4	49.4	6.09	20,000 +	12/10/92	1609	68	gal	lt. pale brown, cloudy
5	48.0	6.04	20,000 +	12/10/92	1623	85	gal	lt. pale brown, cloudy
Extra purges							gal	
After development							gal	

Surge technique: Bail down, let recover
Type, size and capacity of bailer or pump: PVC bailer 3' x 3.0" I.D. = 1½ gal. SC 12/10/92
Quantity of fluid removed: 85 gal.
Time for removal: 1 ¼ hours SC 12/10/92
Comments:

Note: all depths measured from top of casing unless noted Ground surface = G.S.

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APPENDIX A2

Water Quality Field Data Sheets

EBASCO SERVICES INCORPORATED
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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/8/92
Time Start 1035
Time Finish 1105
Samplers R.T. Conon, Willie Franklin

Well No. 1- S

Well Information

Depth to water NA ft.
Casing diameter NA ~~4~~ in. to ___ ft. RTC 1/8/93
Casing stickup NA ft.
Well depth NA ft.
Borehole diameter ? in. to ___ ft.
Screened interval 4 in. to ___ ft.
Sample depth NA ft.
Well volume NA gal.

E.C. meter #2 YSI 910029356
Temp = 19°c ~~1,000~~ 910 umhos/cm

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209A
Water level meter Solinst Serial No. 11747
E.C. meter #1 Hydac Serial No. 9209 A
Dissolved O 2 meter YSI Serial No. 92k43246
Pump NA Serial No. NA
Temperature meter Hydac Serial No. 9209 A
Pumping rate NA gal/min
Filter Apparatus NA
Filters 0.45 μm + 0.10 μm
Tubing Silicon Size 3/8 O.D. in x NA in
Bailer PVC ≈ 1 gal Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 63.6 °F pH 4.00 = 4.20 @ 70.1 °F Time 0750
Conductance standard 1,000 umhos/cm @ 25° C Reading 941 umhos @ 63.6 °F Time 7:50
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 6.40 mg/l @ 9.0 °C (RTC 1/8/93) Time 8:02

Time	Volume Removed		Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	51.6	6,510	8.61	7.4 (8.0°c)	Clear

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/10/93
Time Start 13:52
Time Finish 15:32
Samplers J. Carr, J. Ber, W. Franklin, D. Hanley

Well No. S-4

Well Information

Depth to water 58.24 ft. TOC
Well depth 86.42 ft. TOC
Sample depth 83 ft.
Casing diameter 4 in. to ___ ft.
Borehole diameter 10 in. to ___ ft.
Well volume 41 gal.
Casing stickup 1.9 ft.
Screened interval 63 in. to 83 ft.

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B
E.C. meter Hydac Serial No. 9209B
Pump N/A Serial No. N/A
Pumping rate N/A gal/min
Water level meter Solinst Serial No. N/A
Dissolved O2 meter YSI Serial No. 92K43412
Temperature meter Hydac Serial No. 9209B
Filter Apparatus 142 mm Polycarbonate Filters .45 um 9-10 ...
Tubing Silicon Size 3/8 in x ___ in
Bailer PVC 3' 1" (1 gal) Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 68.2 °C pH 10.00 = 10.00 @ 68.3 °C Time 0731
Conductance standard 1000 umhos/cm @ 25° C Reading 1009 umhos @ 67.6 °C Time 0743
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ ___ °C Time N/A

Time	Volume Removed: Gals	Volume Removed: Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	55.6	8270	8.23	7.9 @ 11°C	very clean
1524	36	36/41	57.7	8900	8.23	10 @ 11°C	cloudy, sandy
14:35	Well bailed dry after 36 gallons removed AW from notes						
15:09	Begin sampling AW from notes						

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/10/93 Samplers J. Coen, J. Benson
Time Start 0856 W. Franklin, D. Bradley
Well No. S-5-~~88~~ Time Finish 1114

Well Information

Depth to water 36.54 ft. Casing diameter 4 in. to ___ ft. Casing stickup 1.6 ft.
Well depth 58.67 ft. Borehole diameter 10 in. to ___ ft. Screened interval 38 ft to 58 ft.
Sample depth 48 ft. Well volume 35 gal.

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B Dissolved O 2 meter YSI 51B Serial No. 92E43412
Pump N/A Serial No. N/A Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min Filter Apparatus 142 mm Polycarbonate Filters .45 um & .10 um
Tubing Silicon Size 3/8 in x NA in Bailer PVC 3' 1" (1 gal) Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 68.2 °F pH 10.00 = 10.00 @ 68.3 °F Time 0731
Conductance standard 10,00 umhos/cm @ 25° C Reading 1009 umhos @ 67.6 °C Time 0743
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ ___ °C Time N/A

Time	Volume Removed Gals	Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	46.6	20,000 +	8.93	2.6 @ 9°C	Clear w/ minor Discoloration
0944	35	1	46.1	20,000 +	8.32	3.1 @ 10°C	cloudy, pale gray color
0959	70	2	45.5	16,130 46.1	7.98	3.6 @ 9.5°C	cloudy, dk pale gray
1012	105	3	51.5	17,490 51.6	7.96	5.0 @ 10.5°C	same as above
1026	140	4	53.6	18,050 53.7	7.95	4.0 @ 11°C	same as above
1041	175	5	53.4	13,710	7.89	4.8 11°C	same as above

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/6/93
Time Start 0945
Time Finish 1510

Samplers Travis Canon, S. DeWitt, Tom O'Neill

Well No. S-6

Well Information

Depth to water 18.05 ft.
Well depth 35.22 ft.
Sample depth 18.05 - 35.22 ft. used 25 ft
Assumed diameter

Casing diameter 4 in. to ~~34~~ 35 ft. RTC 1/6/93
Borehole diameter 10 ~~in.~~ to 46 ft.
Well volume 34.4 stat gal.

Casing stickup 3.03 ft.
Screened interval 15 ~~in.~~ ft to 35 ft.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A
E.C. meter Hydac Serial No. 9209 A
Pump NA Serial No. NA
Pumping rate NA gal/min
Tubing Silicon Size 3/8 O.D. in x NA in

Water level meter Solinst Serial No. 11747
Dissolved O2 meter 51 B Serial No. 92K43246
Temperature meter Hydac Serial No. 9209 A
Filter Apparatus 142 mm Polycarbonate Holder Filters 0.45 μm and 0.10 μm
Bailer PVC ≈ 1 gallon Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.01 @ 64.9 ~~°C~~ F pH 10.00 = 10.28 @ 64.8 ~~°C~~ F Time 7:35

Conductance standard 1,000 umhos/cm @ 25° C Reading 880 umhos @ 64.9 °C Time 7:45

Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed (RTC 1/6/93) Gals	Well ~~Csng~~ Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l RTC	1/6/93 Physical Characteristics
Initial	0	0	49.4F	> 20,000	7.36	~~2.482~~ 2.39	clear 6.8°C
				~~>21,000~~	RTC 1/6/93		
1118	34.4	1st	49.3F	> 20,000	7.48	3.50	slightly murky 6.8°C
1235	34.4	2nd	51.2	> 20,000	7.29	2.80	slightly murky 7.1°C
1334	34.4	3rd	52.7	> 20,000	7.24	2.96	slightly murky but clearer 8.1°C
1410	34.4	4th	50.7	> 20,000	7.14	3.20	slightly murky as above 7.8°C
1500	34.4	5th	47.5	> 20,000	7.16	3.40	slightly murky as above 8.0°C

Note: Well volumes calculated by the following method: 1) V casing + 2) V sand pack around casing + 3) V sand pack below casing to T.D.
See p. 91-95 in logbook.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date: 1/7/93
Time Start: 1019
Time Finish: 1208
Well No. S-7
Samplers: Travis Canon, S. Dewitt, D. Hanley - UXB

Well Information

Depth to water 29.90 ft.
Well depth 54.5 ft.
Sample depth 44 ft.
Casing diameter 4 in. to 54.5 ft.
Borehole diameter 10 in. to 64 ft. (guess 94)
Well volume 53.5 gal.
Casing stickup 2.5 ft.
Screened interval 4 in. to ___ ft. 34-54

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A
E.C. meter Hydac Serial No. 9209 A
Pump NA Serial No. NA
Pumping rate NA gal/min
Water level meter Solinst Serial No. 11747
Dissolved O2 meter YSI Serial No. SN92K43246
Temperature meter Hydac Serial No. 9209 A
Filter Apparatus NA Filters 0.45 µm + 0.10 µm
Tubing Silicon Size 3/8 O.D in x NA in
Bailer ≈1 gal PVC Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.01 @ 54.4 °F pH ~~10.00~~ 4.00 = 3.99 @ 54.4 °F Time 1015
Conductance standard 1,008 umhos/cm @ 25° C Reading 850 umhos @ 54.2 °C Time 1015
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed: Gals	Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	49.1	15,200	6.90	2.0	slightly murky to clear 10
1200	30	1 (Not complete)	53.1	14,900	7.74	4.2 10°C	slightly murky to clear 10°
Only one well volume removed because of slow recharge.							
Sample collected at partial removal.							

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/9/93
Time Start 1320
Time Finish 1437
Samplers J. Coen, J. Bans, W. Franklin, D. Hen,

Well No. S-18-88

Well Information

Depth to water 21.55 ft.
Well depth 39.2 ft.
Sample depth 37 ft.
Casing diameter 4 in. to N/A ft.
Borehole diameter 10 in. to N/A ft.
Well volume 29.9 gal./vol
Casing stickup 1.57 ft.
Screened interval 16 ft. to 36 ft.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter ~~7.0~~ Hydac Hak3 Serial No. 9209B
Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B
Dissolved O2 meter YSI-51B Serial No. 92K43412
Pump N/A Serial No. N/A
Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min
Filter Apparatus 142 mm Polycarbonate Filters
Tubing Silicon Size 3/8 in x NA in
Bailer PVC 3' (1gal) Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.01 @ 67.6 °F pH 10.00 = 10.00 @ 67.7 °C Time 0726
Conductance standard 1000 umhos/cm @ 25° C Reading 1340 umhos @ 68.1 °C Time 0732
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ °C Time N/A

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	52.2	20,000+	7.68	.8 (?) 10°C	Pale Brown
1430	20	1	51.7	20,000+	7.70	4.6 9°C	V. muddy - greenish Brown

* Only bailed partial before going dry; recovery is very slow

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 2/6/93 Samplers S. CONDRAN
Time Start 0940 E. KIELY
Well No. S-19-88 Time Finish 1035

Well Information

Depth to water ~~37.72'~~ ft. SC 2/6/93 Casing diameter 4 in. ~~to ___ ft.~~ SC 2/5/93 Casing stickup 1.92 ft.
Well depth 37.50' ft. Borehole diameter 8 in. ~~to ___ ft.~~ 2/6/93 Screened interval 14.4 in. to 34.4 ft.G.S.
Sample depth 37 ft. Well volume 22 gal.

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Ground Surface = G.S.
Note: All depths measured from top of well casing

Field Equipment

pH meter CAMBRIDGE SCI. Serial No. 9209B Water level meter SOLINST Serial No. EBASCO 100' NO S/N
E.C. meter CAMBRIDGE SCI. Serial No. 9209B Dissolved O2 meter YSI 51B Serial No. 92K43412
Pump NA Serial No. NA Temperature meter CAMBRIDGE SCI. Serial No. 9209B
Bailing ~~Pumping~~ rate SC 2/6/93 .2 gal/min Filter Apparatus Geotech 142 mm filter Filters .45 µm in-line filter, 10 µm flat filter (silicon tubing)
Tubing NA Size NA in x ___ in Bailer PVC 3' x 3" Size 1 gal ~~in~~ SC 2/6/93

Field Chemistry

Calibration pH 7.00 = 7.00 @ 56.7 °F ~~°C~~ 2/6/93 pH 10.00 = 10.00 @ 56.7 °F ~~°C~~ 2/6/93 Time 0815
Conductance standard 1000 umhos/cm @ 25° C Reading 1000 umhos @ 17.5 °C Time 0755
Calibrated conductivity Not calculated umhos/cm @ 25° C Diss. O_2 CALIBRATED W/ HANNA INST. ZERO CAL. SOLN. ~~mg/l @~~ ~~°C~~ SC 2/6/93 Time 0740

Time	Volume Removed		Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	5.5	16,150	7.[illegible]	3.2	CLEAR COLOR, SLIGHT HAZE
0950	2.2	1	8.0	15,880	7.77	3.0	LIGHT BROWN, SILTY
0955	4.4	2	8.0	16,250	7.64	3.0	LIGHT BROWN, SILTY
1003	6.6	3	8.0	15,770	7.58	2.9	CLOUDY, [illegible]
1017	8.8	4	8.0	15,870	7.53	3.0	CLOUDY
1035	11.0	5	7.5	14,940	7.50	2.9	CLEAR
1047	start sampling						

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/7/93
Time Start 1230
Time Finish 1358
Well No. S-64-90

Samplers R.T. Canon
S. DeWitt
D. Honley

Well Information

Depth to water 24.8 ft. Casing diameter 4 in. to 34.5 ft. Casing stickup 2.5 ft.
Well depth 37.15 ft. Borehole diameter 10 in. to 35 ft. Screened interval 4 in. to ___ ft. 24.5 - 34.5
Sample depth 34 ft. Well volume 17.2 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209A Water level meter Solinst Serial No. 11747
E.C. meter YSI Serial No. 91D029356 Dissolved O2 meter YSI Serial No. SN92K43246
Pump NA Serial No. NA Temperature meter Hydac Serial No. 9209 A
Pumping rate NA gal/min Filter Apparatus NA Filters 0.45 µm + 0.10 µm
Tubing Silicon Size 3/8 O.D. in x NA in Bailer ≈ 1 gal PVC Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.01 @ 54.4 °F pH 10.00 = 3.99 @ 54.4 °F Time 1015
Conductance standard 1,000 umhos/cm @ 25° C Reading 850 umhos @ 54.2 °C Time 1015
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed Gals	Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	49.3	25,500 (49.3 °F)	7.49	4.3 (9.2°c)	slightly murky
1	17.2	1 (Full volume)	58.6	25,200 (10.1 °C)	7.61	6.2 (9.9°c)	slightly murky salinity = 22 ‰
13:34	Start Sampling		transfer from notes				

Well S-64-90 went dry after the first well volume. The recharge was slow. Crew collected well sample after the first well volume.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/7/93
Time Start 1540
Time Finish 1640
Samplers R.T. Canon, S. DeWitt, D. Hanley

Well No. S-65-90

Well Information

Depth to water 19.7 ft. Casing diameter 4 in. to 28 ft. Casing stickup 2.5 ft.
Well depth 28.65 ft. Borehole diameter 10 in. to 28 ft. Screened interval 4 in. to ___ ft. (15-25 ft)
Sample depth 28.0 ft. Well volume 14.0 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.

Note: All depths measured from top of well casing
Volume in well casing and saturated annulus

Field Equipment

pH meter Hydac Serial No. 9209A Water level meter Solinst Serial No. 11747
E.C. meter YSI Serial No. 91D029356 Dissolved O2 meter YSI 51B Serial No. SN92K43246
Pump NA Serial No. NA Temperature meter Hydac Serial No. 9209 A
Pumping rate NA gal/min Filter Apparatus NA Filters 0.45 μm + 0.10 μm
Tubing Silicon Size 3/8 O.D. in x NA in Bailer PVC = 1 gal Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.01 @ 54.4 °F pH 10.00 = 3.99 @ 54.4 °F Time 1015
Conductance standard 1,000 umhos/cm @ 25° C Reading 850 umhos @ 54.2 °C Time 1015
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed Gals	Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	57.0	9,200 (9.9°c)	7.48	1.75 (11°c)	cloudy
1549	14	1	48.0	4,600 (5.5°c)	7.47	1.80 (8.4°c)	cloudy

Well S-65-90 went dry after the first well volume. The recharge was slow. Crew collected well sample after the first well volume.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/10/93
Time Start 0919
Time Finish 1137
Samplers R.T. Canon, S. DeWitt, T. O'Neill

Well No. S-66-90

Well Information

Depth to water 38.69 ft.
Well depth 95.34 ft.
Sample depth 94.5 ft.
Casing diameter 4 in. to 95.34 ft.
Borehole diameter 10 in. to 95.34 ft.
Well volume 52.4 gal.
Casing stickup 2.5 ft.
Screened interval 4 in. to A ft. 84-94

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

schedule 80 PVC casing
$r = \frac{3.86}{2}$ inches

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A
E.C. meter Hydac Serial No. 9209 A
Pump NA Serial No. NA
Pumping rate NA gal/min
Tubing Silicon Size 3/8 O.D. in x NA in
Water level meter Solinst Serial No. 11747
Dissolved O2 meter YSI 51B Serial No. 92K43246
Temperature meter Hydac Serial No. 9209A
Filter Apparatus NA
Filters 0.45 µm + 0.10 µm
Bailer PVC = 1 gal Size 3 A x 3 in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 67.6 °F pH 10.00 = 10.07 @ 67.1 °F Time 7:57
Conductance standard 1,000 umhos/cm @ 25° C Reading 977 umhos @ 67.4 °F Time 7:55
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed Gals	Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	51.5	10,780	13.05	1.45 at 10.5 °C	clear
1108	52.4	1	59.1	10,800	9.16	5.5 at 11.7 °C	grey; very murky; grey clay on bailer
1111	Begin Sampling - AW from notes						
The well went dry after one well volume.							

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 2-5-93
Time Start 1235
Time Finish 1405
Samplers E. KIELY, S. CONDRAN

Well No. S-67-90

Well Information

Depth to water 20.38 ft.
Well depth 38.65 ft.
Sample depth 27.0 ft.
Casing diameter 4 in. ~~to ___ ft.~~ EK 2-5-93
Borehole diameter 10 in. ~~to ___ ft.~~ EK 2-5-93
Well volume 27.5 gal.
Casing stickup 2.5 ft.
Screened interval 26 ~~in.~~ to 36 ft. G.S. EK 2-5-93

Calculation: Well volume = $(\pi R^2 H - \pi r^2 H) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft. H = Well depth - Top of Sandpack
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

G.S. = Groundsurface
Note: All depths measured from top of well casing

Field Equipment

pH meter CAMBRIDGE Serial No. 9209B
E.C. meter ~~YSI MODEL 33~~ CAMBRIDGE SCI. Serial No. ~~91D029356~~ 9209B
Pump NA Serial No. NA
~~Pumping~~ BAILING rate ~1.5 gal/min EK 2-5-93
Tubing NA Size NA in x in
Water level meter SOLINST Serial No. EBASCO 100' NO S/N
Dissolved O2 meter YSI 51B Serial No. 92K43412
Temperature meter CAMBRIDGE Serial No. 9209B
Filter Apparatus GEOTECH 142 mm FILTER HOLDER
Filters .45 mm IN-LINE FILTER, .10 mm FLAT FILTER
Bailer PVC 3'x3" Size 1 gal SILICON TUBING ~~in~~ EK 2-5-93

Field Chemistry

Calibration pH 7.00 = 7.00 @ 56.7 °F ~~°C~~ EK 2-5-93 pH 10.00 = 10.00 @ 55.2 °F ~~°C~~ EK 2-5-93 Time 0753

Conductance standard 1000 umhos/cm @ 25° C Reading 900 umhos @ 16 °C Time 0725
CALIBRATED WITH HANNA INST. ~~ZERO~~ SOLN.

Calibrated conductivity Not Calculated umhos/cm @ 25° C Diss. O_2 ~~mg/l @~~ EK 2-5-93 °C Time 0740

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp. °F ~~°C~~ SC 2/5/93	Elec. Conductivity umhos/cm @ °F ~~°C~~ SC 2/5/93	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	~~41.5~~ 45.1 SC 2/5/93	* >20,000	7.57	3.5	clear
1300	1	27.5 SC 2/5/93	34.3	* >20,000	7.72	4.4	Pale brown, silty
1315	55	2	35.9	* >20,000	7.67	3.2	"
1328	82.5	3	36.0	* >20,000	7.63	3.8	"
1350	110	4	39.3	* >20,000	7.52	1.9	"
1405	137.5	5	38.0	* >20,000	7.61	2.8	"
1425	Start Sampling						

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* YSI MODEL 33 NOT FUNCTIONING PROPERLY, USED CAMBRIDGE SCI. SN 9209B SC 2/5/93 ABOVE SCALE > 20,000 umhos/cm

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/9/93 Samplers R. T. Canon
Time Start 0940 S. DeWitt
Well No. S-68-90 Time Finish 1015

Well Information

Depth to water 41.20 ft. Casing diameter 4 in. to 64.15 ft. Casing stickup 2.5 ft.

Well depth 64.15 ft. Borehole diameter 10 in. to 65 ft. Screened interval 4 in. to 1 ft.

Sample depth NA ft. Well volume ~~38.6~~ 32.7 gal. 52.5-62.5

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.

Note: All depths measured from top of well casing. Volume in well casing and saturated annulus

Field Equipment

pH meter Hydac Serial No. 9209 A Water level meter Solinst Serial No. 11747

E.C. meter Hydac Serial No. 9209 A Dissolved O 2 meter YSI 51B Serial No. 92K43246

Pump NA Serial No. NA Temperature meter Hydac Serial No. 9209 A

Pumping rate NA gal/min Filter Apparatus NA Filters 0.45 μm + 0.1 μm

Tubing Silicon Size NA in x in Bailer PVC = 1gal Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 71.5 °F pH 10.00 = 10.08 @ 71.1 °F Time 7:31

Conductance standard 1,000 umhos/cm @ 25° C Reading 861 umhos @ 69.7 °F Time 7:38

Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 3.81 mg/l @ 20.5 °C Time 7:45

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	55.5	10,130	7.58	3.5 at 10.1°C	clear, very slightly murky
1	~~38.6~~ 32.7	1	NA	NA	NA	NA	NA

The bailer stuck in the well at 40 ft and could not be removed or loosened. Crew had to quit at this well site.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 2-4-93
Time Start 1510
Time Finish 1554
Samplers ED KIELY, SARAH CONDRAN

Well No. S-68-90

Well Information

Depth to water 41.45 ft.
Casing diameter 3.86 in. ~~to ___ ft.~~ EK 2-4-93
Casing stickup 2.5 ft.
Well depth 64.40 ft.
Borehole diameter 10 in. ~~to ___ ft.~~ EK 2-4-93
Screened interval 52.5 ~~in.~~ FT EK to 62.5 ft. 65
Sample depth 60 ft. GS
Well volume 29.5 gal.

Calculation: Well volume = $(\pi R^2 H - \pi r^2 H) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft. H = Welldepth - Top of Sandpack
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

GS = GROUND SURFACE

Note: All depths measured from top of well casing

Field Equipment

pH meter CAMBRIDGE Serial No. 9209B Water level meter SOLINST Serial No. EBASCO PROPERTY
E.C. meter CAMBRIDGE Serial No. 9209B Dissolved O2 meter YSI 51B Serial No. 92K43412
Pump N/A Serial No. N/A Temperature meter CAMBRIDGE Serial No. 9209B
BAILING ~~Pumping~~ rate ~.92 gal/min (EK 2-4-93) Filter Apparatus 142 MM GEOTECH FILTER HOLDER Filters .45 INLINE / .10 FLAT FILTER
Tubing NA Size NA in x in Bailer PVC Size 3.0' x 3.0" in SILICON TUBING

Field Chemistry

Calibration pH 7.00 = 7.00 @ 25 °C pH 10.00 = 10.04 @ 25 °C Time 0720
Conductance standard ~~10000~~ 1000 umhos/cm @ 25° C Reading ~~1055~~ 1055 EK umhos @ 25 °C Time 0750
Calibrated conductivity NOT CALCULATED umhos/cm @ 25° C Diss. O_2 CALIBRATED WITH HANNA INST. & OXYGEN SOLN ~~mg/l @~~ EK 2-4-93 °C Time 0755

Time	Volume Removed Gals	Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	36.7	19,400	6.70	3.8	CLEAR
1510	29.5	1	35.3	>20,000	6.27	2.4	CLOUDY, GRAYISH BROWN
1542	59	2	46.4	* 12,360	6.20	3.0	BROWN, SILTY
1548 ~~1554~~ (2-4-93 EK)	WELL BAILED DRY AGAIN AFTER 68 GALLONS REMOVED. WILL SAMPLE WHEN RECHARGED.						
1554	INITIATED SAMPLING						

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* FIGURE SUSPECT, METER NOT FUNCTIONING WELL DUE TO COLD WEATHER.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/9/93
Time Start 1143
Time Finish 1301

Samplers J. Coen, J. Bens, W. Franklin, D. Harley

Well No. S-70-92

Well Information

Depth to water 46.06 ft.
Casing diameter 4 in. to TD ft.
Casing stickup 2.5 ft.
Well depth 52.06 ft.
Borehole diameter 10 in. to TD ft.
Screened interval 40 ft. to 50 ft.
Sample depth ______ ft.
Well volume 10.2 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B
Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B
Dissolved O2 meter YSI 51B Serial No. 92K43412
Pump N/A Serial No. N/A
Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min
Filter Apparatus 142 mm Polycarbonate Filters .45 um & .10 um
Tubing Silicon Size 3/8" in x NA in
Bailer PVC 3' 1" (1 Gal) Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.01 @ ______ °C pH 10.00 = 10.00 @ 67.7 °F Time 0726
Conductance standard 1000 umhos/cm @ 25° C Reading 1340 umhos @ 68.1 °F Time 0732
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ N/A °C Time N/A

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	57.6	20,000+	8.6	7.3 12°C	Clear
1214	10.2	1	51.7	20,000+	8.3	8.4 11°C	pale gray-cloudy
1231	16	6 gal	49.4	20,000+	8.0	8.2 16°C	muddy-brown
		→ 6 gallons were bailed before it went dry					

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/10/93
Time Start ~~1246~~ 1246
Time Finish 1503

Samplers R.T. Canon, S. De Witt, T. O'Neill

Well No. S-71-90

Well Information

Depth to water 42.32 ft.
Well depth 70.98 ft.
Sample depth 70 ft.

Casing diameter 4 in. to 71 ft.
Borehole diameter 10 in. to 71 ft.
Well volume 39.3 gal.

Casing stickup 2.5 ft.
Screened interval 4 in. to A ft.
58-68

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A
E.C. meter Hydac Serial No. 9209A
Pump NA Serial No. NA
Pumping rate NA gal/min
Tubing Silicon Size 3/8 O.D in x NA in

Water level meter Solinst Serial No. 11747
Dissolved O2 meter YSI 51B Serial No. 92K43246
Temperature meter Hydac Serial No. 9209A
Filter Apparatus NA
Filters 0.45 μm + 0.10 μm
Bailer PVC ≈ 1 gal Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 67.6 °F (AW 4/6/93) pH 10.00 = 10.07 @ 67.1 °F Time 7:57 am
Conductance standard 1,000 umhos/cm @ 25° C Reading 977 umhos @ 67.4 °F (AW 4/6/93) Time 7:55 Am
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 NA mg/l @ NA °C Time NA

Time	Volume Removed		Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	54.2	9,630	9.03	2.1 at 10.6°C	clear
1341	22	1	58.8	10,100	7.94	6.6 at 10.2°C	murky

Well went dry after this many gallons and recharged very slowly. Due to the slow recharge this well took close to 2 hours to complete ~~complete~~ (RTC 1/10/93) sampling.

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/5/93
Time Start 1302
Time Finish 1630
Samplers Jon Cien, J. Benix, W. Franklin, T. ONeill

Well No. S-93-92

Well Information

Depth to water 66.45 ft. Casing diameter 4 in. to TD ft. Casing stickup 2.4 ft.

Well depth 153.65 ft. TOC Borehole diameter 7 7/8 in. to TD ft. Screened interval 136 to 150 ft.

Sample depth 150 ft. Well volume 68.1 gal.

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h \times 7.48\ \frac{gal}{ft^3}$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B Water level meter Solinst Serial No. N/A

E.C. meter Hydac Serial No. 9209B Dissolved O2 meter 51B Serial No. 92K43412

Pump N/A Serial No. N/A Temperature meter N/A Serial No. N/A

Pumping rate N/A gal/min Filter Apparatus 142mm Polycarbonate Holder Filters .45 um & .10 um

Tubing Silicon Size 3/8 O.D. in x NA in Bailer PVC 3ft 1 in Size 3 O.D. in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 38.6 °C pH 10.00 = 10.02 @ 39 °C Time 1316

Conductance standard 1000 umhos/cm @ 25° C Reading 1000 umhos @ 10 °C Time 1322

Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ ~~70~~ Time ~~1326~~

Time	Volume Removed Gals	Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	10°C	1000	7.78	2.8 m/l	Clear/Murky
1455	68.1	1	10°C	1300.32	7.36	2.5 m/l	Murky
WELL SAMPLED AFTER SUFFICIENT RECOVERY AND BEING BAILED DRY.							

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/6/93 Samplers J. Cock, W. Franklin
Time Start 1126 J. Benson
Well No. S-95-92 Time Finish 1354

Well Information

Depth to water 29.58 ft. TOC
Casing diameter 4 in. to ~~33~~ 131 ft. AW 4/6/93
Casing stickup 2.3 ft.
Well depth ~~29.58~~ 130.3 ft. TOC jc 1/6/93
Borehole diameter 7 3/8 in. to ~~7/8~~ 131 ft ~~7.375~~
Screened interval 104.8 ft to 130.3 ft.
Sample depth ~126 ft. AW 4/4/93
Well volume AW 4/4/93 ~~400.65~~ 80.1 gal gal. AW 4/6/93 5 volumes: 400.5 gallons
Top of Sand 99.5 ft

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment °C = 1.6

pH meter Hydac Serial No. 9209B Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B Dissolved O 2 meter YSI Serial No. 92K43412
Pump N/A Serial No. N/A Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min Filter Apparatus In-Line (.45) 142 Polycarbonate Filters .45um & .10um
Tubing Silicon Size 3/16 OD in x NA in Bailer PVC 3'1" Size 3" O.D in

Field Chemistry

Calibration pH 7.00 = 7.00 @ ~~72.6~~ 69.5 jc AW 4/6/93 °F pH 10.00 = 10.00 @ ~~73.5~~ 69.5 jc °F Time 0736
Conductance standard 1000 umhos/cm @ 25° C Reading 1320 umhos @ 69.6 °F Time 0746
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ N/A °C Time ~~0755~~ N/A jc 1/6/93

Time	Volume Removed		Temp. °F	Elec. Conductivity umhos/cm @ °F	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	~~58.1~~ 55.4 jc 1/6/93	8360/57.2	8.12	9.2/12°C	Clear, no odor
1302	80.13	1	57.4	8440/57.3	8.07	7.0/13°C	cloudy, no odor
	73.9					continuing	to drop to 6.2
	actual vol when well dried up						
SAMPLED AFTER SUFFICIENT RECOVERY, WELL BAILS DRY.							

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/8/93 9
Time Start 0900
Time Finish 1056

Samplers J. Coen, J. Benso, W. Franklin, D. Henley

Well No. S-96-92

Well Information

Depth to water 69.82 ft.
Well depth 116.69 ft.
Sample depth 114 ft.
Casing diameter 4 in. to TD ft.
Borehole diameter 10 in. to TD ft.
Well volume ~52 gal.
Casing stickup 2.4 ft.
Screened interval 101.9 ft. to 116.9 ft. TOC

Calculation: Well volume = $(\pi R^2h - \pi r^2h) \times .3 + \pi r^2h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Delayed

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 B
E.C. meter Hydac Serial No. 9209B
Pump N/A Serial No. N/A
Pumping rate N/A gal/min
Tubing Silicon Size 3/8 in x NA in
Water level meter Solinst Serial No. N/A
Dissolved O2 meter YSI-51B Serial No. 92K43412
Temperature meter Hydac Serial No. 9209 B
Filter Apparatus 142 mm Polycarbonate Filters .45 um & .1 um
Bailer PVC 3' 1" (1 Gal) Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 67.6 °F pH 10.00 = 10.00 @ 67.7 °F Time 0726
Conductance standard 1000 umhos/cm @ 25° C Reading 1340 umhos @ 68.1 °F Time 0733
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ °C Time N/A

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °F	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	54.6	13,720 @ 54.7	8.7	5.5 11°C	Clear
0959	52	1	52.6	12,450 @ 52.6	8.4	7.2 10.5°C	Cloudy - Gray Color
	Bailed 39 gallons = dry						
1025	Let water recover to 106 ft; Then bailed dry and will sample						

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Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Well No. S-97-92 (dc 1/6/93)
Date 1/6/93
Time Start 1450
Time Finish 1545
Samplers J. Coan J. Benson W. Franklin

Well Information

Depth to water 71.3 ft.
Well depth 85.5 (well Depth) ft.
Sample depth 80 ft.
Sand Pack Depth Not Required ft
Casing diameter 4 in. to NA ft.
Borehole diameter 7 7/8 in. to NA ft.
Well volume (16 gal) 80 gal.
Casing stickup 2.5 ft.
Screened interval 75 ft to 85 ft. WITH STICKUP

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B Water level meter UNKNOWN Serial No. N/A
E.C. meter Hydac Serial No. 9209B Dissolved O 2 meter 51B Serial No. 92K43412
Pump N/A Serial No. N/A Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min Filter Apparatus 142 mm Polycarb Filter Holder Filters .45um & .10um
Tubing Silicon Size 3/8 OD in x NA in Bailer PVC 3ft 1in Size 3 OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 69.4 °F (AW 1/6/93) pH 10.00 = 10.01 @ 69.6 °F Time 1441
Conductance standard 1000 umhos/cm @ 25° C Reading 1003 umhos @ 64.2 °F (AW 1/6/93) Time 1441
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ °C Time N/A

Time	Volume Removed Gals	Csng Vols	Temp. °C	Elec. Conductivity umhos/cm @ °F (AW 1/6/93)	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	50.5	14040/54.7	7.61	7.1 mg/l / 12C	Clear
1545	16	1	61.4	16180/63.6	7.57	7.4 12°C	Cloudy, no odor
WELL BAILED DRY, SAMPLED AFTER SUFFICIENT RECOVERY.							

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 2/4/93 Samplers E. KIELY
Time Start 12:30 S CONDRAN
Well No. S-98-92 Time Finish 12:44

Well Information

Depth to water 30.42 ft. Casing diameter 4 in. ~~to ft.~~ sc 2/4/93 Casing stickup 2.5 ft.

Well depth 41.70 ft. Borehole diameter 7.38 in. ~~to ft.~~ sc 2/4/93 Screened interval 28.7 in. to 38.7 ft. G.S.

Sample depth 41.0 ft. Well volume 12.7 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

G.S. = Ground Surface
Note: All depths measured from top of well casing

Field Equipment

pH meter CAMBRIDGE SCI. Serial No. 9209B Water level meter SOLINST Serial No. EBASCO 100' NO S/N

E.C. meter CAMBRIDGE SCI Serial No. 9209B Dissolved O2 meter YSI 51B Serial No. 92K43412

Pump NA Serial No. NA Temperature meter Cambridge Scientific Serial No. 9209B

Bailing ~~Pumping~~ rate ~1 gal/min sc 2/4/93 Filter Apparatus Geotech 142MM filter holder Filters .45 μm in-line prefilter .10 μm flat filter (silicon tubing)

Tubing NA Size NA in x in Bailer PVC 3'x 3" Size 1 gal ~~in~~ sc 2/4

Field Chemistry

Calibration pH 7.00 = 7.00 @ 25 °C pH 10.00 = 10.004 sc 2/4/93 @ 25 °C Time 0720

Conductance standard 1,000 ~~10,000~~ Siemens ~~umhos~~/cm sc 2/4/93 @ 25° C Reading 1055 ~~10,550~~ umhos @ 25 °C Time 0750

Calibrated conductivity Not calculated Siemens ~~umhos~~/cm sc 2/4/93 @ 25° C Diss. O_2 CALIBRATED W/ HANNA INST. ZERO CAL SOLN. ~~°C~~ sc 2/4/93 Time 0755

Time	Volume Removed		Temp. °C	Elec. Conductivity Siemens ~~umhos~~/cm @ °C sc 2/4/93	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	7.8	>20,000	6.03	3.75	clear
1243	12.7	1	8.0	>20,000	6.21	3.80	Pale yellow brown
1244	13gals removed from well, well bailed dry and is slow to recover						
1310	Start sampling						

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/9/93
Time Start 1144
Time Finish 1300
Well No. S-99-92
Samplers Travis Conon, S. DeWitt, Tom O'Neill

Well Information

Depth to water 32.71 ft.
Well depth 40.77 ft.
Sample depth 38 ft.
Casing diameter 4 in. to 40.77 ft.
Borehole diameter 8 in. to 41 ft.
Well volume 10.1 gal gal.
Casing stickup 2.3 ft.
Screened interval 4 in. to ___ ft. 28.0-38.0

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A
Water level meter Solinst Serial No. 11747
E.C. meter Hydac Serial No. 9209 A
Dissolved O2 meter YSI 51B Serial No. 92K43246
Pump NA Serial No. NA
Temperature meter Hydac Serial No. 9209 A
Pumping rate NA gal/min
Filter Apparatus NA
Filters 0.45 µm + 0.10 µm
Tubing Silicon Size 3/8 OD in x NA in
Bailer PVC ≈ 1 gal Size 3 ft x 3 in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 71.5 °F pH 10.00 = 10.08 @ 71.1 °F Time 7:31
Conductance standard 1,000 umhos/cm @ 25° C Reading 861 umhos @ 69.7 °F Time 7:38
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 3.81 mg/l @ 20.5 °C Time 7:45

Time	Volume Removed		Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	53.6	18,170	7.09	5.2 at 10.5 °C	slightly murky
1215	10	1	53.7	17,890	7.07	4.4 at 10.7 °C	slightly murky
1239	4	~~1.5~~ 2 RTC 1/9/93	54.0	18,630	7.14	4.7 at 10.1 °C	slightly murky

WELL SAMPLED ONCE IT RECOVERED AFTER BEING BAILED DRY.

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/7/93
Time Start 0903
Time Finish 1143
Samplers J. Coen, J. Benso, T. Oneill

Well No. S-100-92

Well Information

Depth to water 52.88 ft.
Casing diameter 4 in. to TD ft.
Casing stickup 2.5 ft.
Well depth ~~74.40~~ 77.10 ft.
Borehole diameter 7 3/8 ~10" in. to TD ft.
Screened interval 61.8 ft. to 76.8 ft.
Sample depth 75 ft.
Well volume 26 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B
Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B
Dissolved O2 meter YSI-51B Serial No. 92EN3412
Pump N/A Serial No. N/A
Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min
Filter Apparatus 142mm Polycarbonate Holder Filters .45um & .10um
Tubing Silicon Size 3/8" OD in x 3/8" OD in
Bailer 3ft 1in Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 69.9 °F pH 10.00 = 10.00 @ 70.1 °F Time 0730
Conductance standard 1000 umhos/cm @ 25° C Reading 998 umhos @ 70.1 °F Time 0804
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ °C Time N/A

Time	Volume Removed Gals	Volume Removed Csng Vols	Temp. °F	Elec. Conductivity umhos/cm @ °F	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	58.8	8540/58.3	8.55	7.6 11°C	Clean
1032	26	1	57.0	8170/56.8	8.15	8.4 11°C	Muddy, No Odor
1038	28	Bailed well dry at this point					

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/9/93 Samplers R.T. Canon
Time Start 1330 S. DeWitt
Well No. S-101-92 Time Finish 1419 T. O'Neill

Well Information

Depth to water 41.84 ft. Casing diameter 4 in. to 52 ft. Casing stickup 2.4 ft.
Well depth 52.64 ft. Borehole diameter 8 in. to 52 ft. Screened interval 4 in. to 1 ft.
Sample depth 50 ft. Well volume 11.0 gal. 40.0-50.5

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209 A Water level meter Solinst Serial No. 11747
E.C. meter Hydac Serial No. 9209 A Dissolved O2 meter YSI 51B Serial No. 92K43246
Pump NA Serial No. NA Temperature meter Hydac Serial No. 9209 A
Pumping rate NA gal/min Filter Apparatus NA Filters 0.45 μm + 0.10 μm
Tubing Silicon Size 3/8 O.D in x NA in Bailer PVC = 1 gal Size 3ft x in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 71.5 °F pH 10.00 = 10.08 @ 71.1 °F NW 1/9/93 Time 0731
Conductance standard 1,000 umhos/cm @ 25° C Reading 861 umhos @ 69.7 °F Time 0738
Calibrated conductivity NA umhos/cm @ 25° C Diss. O_2 3.81 mg/l @ 20.5 °C Time 0745

Time	Volume Removed: Gals	Volume Removed: Csng Vols	Temp. °F (KW 1/9/93)	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
Initial	0	0	55.0	18,490	7.29	5.2 at 11.8°C	clear
1341	11	1	56.3	18,480	7.19	6.3 at 11.0°C	murky
1400	∅	~~NW 1/9/93~~ 2 NK	57.5	18,200	7.45	5.25 at 11.0°C	murky
WELL BAILED DRY AFTER 1 VOLUME REMOVAL, SLOW TO							
RECOVER AND SAMPLED ONCE IT DID							

Rev. 11/9/92

EBASCO SERVICES INCORPORATED
2111 Wilson Blvd., Ste. 1000, Arlington, VA 22201

Water Quality Field Data Sheet

TEAD - South Area RFI - Phase II - Group 1 SWMUs

Date 1/7/93
Time Start 1348
Time Finish 1530
Samplers J. Coen, J. Ben
T. Oneill

Well No. S-102-92

Well information

Depth to water 36.25 ft.
Casing diameter 4 in. to TD ft.
Casing stickup 2.5 ft.
Well depth 46.12 ft.
Borehole diameter 10 7/8 in. to TD ft.
Screened interval 33.5 ft. to 43.5 ft. G.S.
Sample depth 41 ft.
Well volume 16.73 gal.

Calculation: Well volume = $(\pi R^2 h - \pi r^2 h) \times .3 + \pi r^2 h$
Where R = Borehole radius in ft.
r = Casing radius in ft.
h = Well depth - depth to water in ft.
Volume in well casing and saturated annulus

Note: All depths measured from top of well casing

Field Equipment

pH meter Hydac Serial No. 9209B Water level meter Solinst Serial No. N/A
E.C. meter Hydac Serial No. 9209B Dissolved O2 meter YSI-51B Serial No. 952KN3412
Pump N/A Serial No. N/A Temperature meter Hydac Serial No. 9209B
Pumping rate N/A gal/min Filter Apparatus 142mm Polycarbonate Filters .45 um & .10 um
Tubing Silicon Size 3/8 in x NA in Bailer PVC 3' 1" Size 3" OD in

Field Chemistry

Calibration pH 7.00 = 7.00 @ 69.9 °F pH 10.00 = 1000 @ 70.1 °C Time 0730
Conductance standard 1000 umhos/cm @ 25° C Reading 1001 umhos @ 70.1 °C Time 0804
Calibrated conductivity N/A umhos/cm @ 25° C Diss. O_2 N/A mg/l @ °C Time N/A

Time	Volume Removed		Temp. °F	Elec. Conductivity umhos/cm @ °C	pH	Dissolved O_2 mg/l	Physical Characteristics
	Gals	Csng Vols					
Initial	0	0	56.7	1680	8.11	8.6 @ 12°C	slightly cloudy
1422	17	1	52.5	20,000+	7.82	8.9 @ 12°C	murky, cloudy
1431	34	2	53.5	20,000+	7.72	8.4 11°C	murky, cloudy
1442	51	3	54.0	20,000+	7.92	9.0 11.5°C	muddy - getting clearer
1453	68	4	52.8	20,000+	7.95	8.5 11.5°C	murky but clearer
1501	85	5	52.7	20,000+	7.99	8.4 10.0°C	same as above

APPENDIX A3

Geotechnical Data

Summary of Geotechnical Analyses - SWMU 1 and 25

A total of 40 samples were submitted for geotechnical analysis from both SWMUs 1 and 25. Only four samples were coarse grained material as determined by the Unified Soil Classification System (USCS) and all these were surficial samples. All the remaining samples, whether from shallow borings or wells, were fine grained silts and clays.

SWMU 1 Geotechnical Summary

Twelve soil samples from ten locations were submitted for geotechnical analysis at SWMU 1. Eight of these samples were surficial type grab samples, while four samples were from two SWMU 1 wells, S-93-92 and S-96-92. The sample depths for the well samples were typically the one or two intervals above the bottom of the boring which roughly corresponds to the water bearing zone.

Only one of these samples 01-IAM-08 was determined to be coarse grained. It is a silty sand, SM, according to the USCS. All the other samples were high and low plastic silts and clays, ML, CL and CH. Moisture contents ranged from 14.9 (01-MSD-58) to 31.9 percent (S-93-92, 148-150 ft). This range of moisture values for the observed soil types represent damp to moist conditions.

Total organic carbon (TOC) values were all moderate to low. Only two locations were above 1 percent, 01-TA-301 and 01-HBA-84 at 2.35% and 1.11%, respectively. All pH values were slightly alkaline with a range of 7.6 at 01-MSD-58 to 9.6 at 01-IAM-13.

SWMU 25 Geotechnical Summary

At SWMU 25 twelve, relatively, shallow soil samples were submitted for geotechnical analysis along with 16 samples from the seven SWMU 25 wells, S-95-92, S-97-92, S-98-92, S-99-92, S-100-92, S-101-92 and S-102-92. Among the shallow borings, six were surficial grab samples, three were collected from 4-5 feet and three from 9-10 feet. The samples selected from the well

locations were typically collected at intervals near but above the top of the water bearing zone and one which coincides closely with the total well depth.

Only three samples were comprised of coarse-grained materials. All were surficial samples and classified as silty sands, (SM), from locations 25-AM-58, 25-IBA-60 and 25-WIND. All the remaining material was rather homogeneous and was classified as high or low plastic silts and clays (ML, MH, CL, CH). Moisture contents ranged from a low of 8.2 percent in the surficial sand at 25-IBA-60 to a high of 69.4 percent in a high plastic clay at S-100-92, 72-74 feet. For these soil types the materials revealed damp to moist conditions.

TOC values were also moderate to low but with a high of 3.82% at 25-IBA-60. The remaining TOC values for SWMU 25 samples were less than 1 percent. The pH values ranged from 7.7 to 10.0 at 25-ODC-108 and 25-AM-58 respectively. The conditions are predominately alkaline with a more common pH range between 8.2 and 9.5 in the remaining samples.

Huntingdon
Consulting Engineers Environmental Scientists

025C EXTRA COPY
Chen-Northern, Inc.
96 South Zuni Street
Denver, Colorado 80223
(303) 744-7105
Fax: (303) 744-0210

June 21, 1993

Ebasco Services Inc.
143 Union Boulevard
Suite 1010
Lakewood, Colorado 80228

Attention: Ms. Pamela Moss

Subject: Laboratory Test Results, Tooele Army Depot

Job No. 1 473 93

Dear Ms. Moss:

We have completed the testing you requested for the subject project. The results of the gradation tests are given in the enclosed Table I and the results of the moisture content, Atterberg limits, pH, and Total Organic Content tests as well as the USCS classifications are given in the enclosed Table II. I am also enclosing two copies of the laboratory work sheets, a diskette with the data in ASCII format, and the chain-of-custody forms.

Thank you for this opportunity to assist you with your testing needs. Please call if you have any questions regarding this project.

Sincerely,
Huntingdon, Chen-Northern, Inc.

Samuel D. Urton

Samuel D. Urton, E.I.T.
Laboratory Manager

SDU/sdu
enclosures

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DENVER REGIONAL OFFICE

TABLE II
TEST RESULTS

JOB NO. 1 473 93

Sample No.	Moisture Content %	Liquid Limit	Plasticity Index	pH	TOC %	USCS class.
01-TA-30-1 or 2 @ 0'	20.9	39	19	9.0	2.35	CL
25-AM-58 @ 0'	14.6	NV	NP	10.0	0.92	SM
01-HBA-84 @ 0'	24.5	43	15	8.0	1.11	ML
25-WIND @ 0'	11.1	NV	NP	9.5	0.69	SM
25-AM-58 @ 4-5'	18.9	43	17	9.8	0.12	CL
25-CT-07 @ 0'	12.9	30	11	8.9	0.60	CL
25-WIND @ 4-5'	18.8	37	17	8.5	0.40	CL
01-MSD-58 @ 0'	14.9	NV	NP	7.6	0.50	ML
01-IAM-08 @ 0'	16.6	NV	NP	9.0	0.58	SM
01-MP-82 @ 0'	29.8	38	9	8.4	0.93	ML
01-PCA-88 @ 0'	20.3	NV	NP	8.6	0.62	ML
25-IDC-10 @ 0'	14.3	37	18	8.2	0.34	CL
25-ODC-108 @ 0-2"	77.6	25	7	7.7	0.77	CL-ML
01-CP-44 @ 0'	23.1	41	14	8.4	0.72	ML
S-98-92 @ 39-41'	40.7	71	41	8.3	0.13	CH
S-98-92 @ 34-36'	25.2	57	33	8.6	0.13	CH
S-97-92 @ 74-76'	39.9	43	19	8.4	0.09	CL
S-97-92 @ 78-81'	33.5	46	24	8.1	0.10	CL
S-102-92 @ 39-41'	32.0	46	16	8.2	0.12	ML
S-102-92 @ 44-46'	43.3	44	11	8.2	0.11	ML

TABLE II (cont.)
TEST RESULTS

JOB NO. 1 473 93

Sample No.	Moisture Content %	Liquid Limit	Plasticity Index	pH	TOC %	USCS class.
25-IBA-60 @ 0'	8.2	NV	NP	9.5	3.82	SM
25-WIND @ 9-10'	20.8	38	16	8.2	0.38	CL
S-100-92 @ 67-71'	51.5	60	18	8.3	0.13	MH
S-100-92 @ 72-74'	69.4	71	40	8.2	0.13	CH
S-102-92 @ 29-31'	26.3	42	16	8.2	0.12	ML
S-102-92 @ 34-36'	32.5	36	8	8.4	0.12	ML
S-101-92 @ 44-46'	19.1	40	22	8.2	0.13	CL
S-101-92 @ 49-50'	25.9	37	14	8.4	0.12	CL
25-AM-58 @ 9-10'	20.0	33	13	8.8	0.12	CL
Test Hole (S-93-92) @ 144-145.2'	31.2	54	29	8.5	0.18	CH
Test Hole (S-93-92) @ 148-150'	31.9	64	42	8.8	0.26	CH
S-95-92 @ 109-111'	38.2	75	49	8.5	0.12	CH
S-95-92 @ 129-131'	38.2	53	28	7.9	0.15	CH
S-96-92 @ 109-110'	28.1	69	45	8.8	0.17	CH
S-96-92 @ 110-111'	25.7	35	17	9.2	0.11	CL
S-99-92 @ 34-36'	27.1	41	17	8.7	0.16	CL
S-99-92 @ 39-40'	32.6	42	18	8.3	0.14	CL
25-ODC-108@9-10'	23.9	25	6	9.2	0.18	CL-ML
01-IAM-13 @ 0'	21.2	31	6	9.6	0.76	ML
25-ODC-108 @ 4-5'	24.3	53	33	9.1	0.26	CH

P.02 EBASCO ENVIRONMENTAL 303 980 3539 04-15-1993 08:19

RED
1 of

EBASCO SERVICES INCORPORATED

Chain-of-Custody Record - Soil

Project Name:
TEAD - South Area
RFI - Phase II Group 1 SWMUs

Sample Date: (M/D/Yr) 4/15/93

Samplers: (Signature) Alan Warner

Site Type	Site Identification	Sample Tag Number	Time (Military Standard)	Sample Depth (Feet)	SAMPLE TECHNIQUE	MOISTURE CONTENT	SOIL PH	SOIL CONDUCTIVITY	GRAIN SIZE	ATTERBERG LIMITS	USCS	SOIL TOC	NUMBER OF CONTAINERS	REMARKS
BORE	01-TA-30 ~~-1~~ AW 4/15/93	NA	NA	~~N~~ NA	NA	X	X	X	X	X	X	X	2	Includes both 30-1 & 30-2
	25-AM-58			NA									1	
	01-HBA-84			NA									2	
	25-WIND			NA									1	
	25-AM-58			4-5									1	Ignore analysis on label
	25-CT-07			NA									1	
	25-WIND			4-5									1	
	01-MSD-58			NA									1	
	01-IAM-08			NA									1	
	01-MP-82			NA									1	
	01-PCA-88			NA									2	
	25-IDC-10			NA									2	
	25-ODC-108			0-2"									2	

FOR ALL JARS Ignore any analysis label on bottles

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)
Alan Warner	4/15/93 (1300)	FED EX	Fed Ex	4/16/93 (1000)	Samuel D. Ustan
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )		
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )		

Air Bill Number FedEx 42155 99511
Sample Split Date
Sample Extraction Date
Sample Analysis Date

dc
20

EBASCO SERVICES INCORPORATED

Chain-of-Custody Record - Soil

Project Name:
TEAD - South Area
RFI - Phase II Group 1 SWMUs

Sample Date: (M/D/Yr) 4/15/93

Samplers: (Signature) Alan Warner

Site Type	Site Identification	Sample Tag Number	Time (Military Standard)	Sample Depth (Feet)	SAMPLE TECHNIQUE	MOISTURE CONTENT	SOIL PH	SOIL CONDUCTIVITY	GRAIN SIZE	ATTERBERG LIMITS	USCS	SOIL TOC	NUMBER OF CONTAINERS	REMARKS
BORE	01-CP-44	NA	NA	NA	NA	X	X	X	X	X	X	X	1	Ignore Analysis label

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)
Alan Warner	4/15/93 (1309)	FED EX	FED EX	4/19/93 ( )	Samuel D. [illegible]
	( )			( )	

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Date/Time (M/D/Yr)
	( )		( )
	( )		( )

Air Bill Number # 4215599511
Sample Split Date ____
Sample Extraction Date ____
Sample Analysis Date ____

JR

EBASCO SERVICES INCORPORATED

Chain-of-Custody Record - Soil

Project Name: TEAD - South Area RFI - Phase II Group 1 SWMUs	Sample Date: (M/D/Yr) 4/15/93
Samplers: (Signature) Alan Warner	

Site Type	Site Identification	Sample Tag Number	Time (Military Standard)	Sample Depth (Feet)	Sample Technique	Moisture Content	Soil PH	Soil Conductivity	Grain Size	Atterberg Limits	USCS	Soil TOC	Number of Containers	Remarks
BORE	S-98-92	NA	NA	39-41	NA	X	X	X	X	X	X	X		
	S-98-92			34-36										
	S-97-92			74-76										
	S-97-92			79-81										
	S-102-92			39-41										
	S-102-92			44-46										
	25-AM-58			4-5									1	Ignore Analysis label on Bottle
	25-WIND			4-5									1	
	25-IPA-60			NA									1	
	25-WIND			9-10									2	
	25-IDC-10			N/A									1	

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)
Alan Warner	(1300) 4/15/93	FED EX	Fed Ex	( ) 4/19/93	Samuel D. Unton
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )		
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )		

Air Bill Number # 4215599511

Sample Split Date ______

Sample Extraction Date ______

Sample Analysis Date ______

Previously Logged

SR-1

EBASCO SERVICES INCORPORATED

Chain-of-Custody Record - Soil

Project Name:
TEAD - South Area
RFI - Phase II Group 1 SWMUs

Sample Date: (M/D/Yr) 4/15/93

Samplers: (Signature) Alan Warner

Site Type	Site Identification	Sample Tag Number	Time (Military Standard)	Sample Depth (Feet)	Sample Technique	Moisture Content	Soil pH	Soil Conductivity	Grain Size	Atterberg Limits	USCS	Soil TOC	Number of Containers	Remarks
BORE	S-100-92	NA	NA	67-71	NA	X	X	X	X	X	X	X	2	
	S-100-92			72-74										
	S-102-92			29-31										
	S-102-92			34-36										
	S-101-92			44-46										
	S-101-92			49-50										
	25-AM-58			9-10										Ignore Analysis on label
	25-AM-58			4-5										" " " "

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)
Alan Warner	4/15/93 (1300)	FED EX	Fed Ex	4/19/93	Samuel D. Victor

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Date/Time (M/D/Yr)	
				Air Bill Number # 4215599511
				Sample Split Date
				Sample Extraction Date
				Sample Analysis Date

Previously Logged

Blue

EBASCO SERVICES INCORPORATED

Chain-of-Custody Record - Soil

Project Name: TEAD - South Area RFI - Phase II Group 1 SWMUs	Sample Date: (M/D/Yr) 4/15/93
Samplers: (Signature) Alan Warner	

Site Type	Site Identification	Sample Tag Number	Time (Military Standard)	Sample Depth (Feet)	Sample Technique	Moisture Content	Soil PH	Soil Conductivity	Grain Size	Atterberg Limits	USCS	Soil TOC	Number of Containers	Remarks
BORE	Test Hole (S-93-92)	NA	NA	144-145.2	NA	X	X	X	X	X	X	X	2	
	Test Hole (S-93-92)			148-150		X	X	X	X	X	X	X	2	
	S-95-92			109-111									2	
	S-95-92			129-131									2	
	S-96-92			109-110									2	
	S-96-92			110-111									2	
	S-99-92			34-36									2	
	S-99-92			39-40									2	
	25-ODC-108			9-10									2	Ignore Analysis on label
	01-IAM-13			NA									1	
	25-ODC-108			4-5									2	
	01-NBA-84			NA									1	
	01-ACA-88			NA									1	

Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr)	Received by: (Signature)
Alan Warner	4/15/93 (13:00)	FED EX	Fed Ex	4/19/93 ( )	Samuel D. Unton
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )	Air Bill Number	# 4215599511
				Sample Split Date	
Relinquished by: (Signature)	Date/Time (M/D/Yr) ( )	Received by: (Signature)	Date/Time (M/D/Yr) ( )	Sample Extraction Date	
				Sample Analysis Date	

Previously Logg

TABLE I

GRADATION TEST RESULT

JOB NO. 1 473 93

% PASSING MECHANICAL SIEVE											
Sample No.	No. 16	No. 30	No. 50	No. 100	No. 200	Part Diam.	% Pass	Part Diam.	% Pass	Part Diam.	%
01-TA-30-1 OR 2 @ 0'	100	99	98	94	84	0.058	75	0.042	73	0.022	
25-AM-58 @ 0'	100	54	39	26	18	0.072	15	0.051	11	0.026	
01-HBA-84 @ 0'	100	99	98	95	93	0.057	82	0.042	73	0.022	
25-WIND @ 0'	100	61	45	31	24	0.070	22	0.050	18	0.025	
25-AM-58 @ 4 - 5'	100	98	94	87	83	0.057	81	0.041	75	0.021	
25-CT-07 @ 0'	100	100	99	99	98	0.052	97	0.038	91	0.020	
25-WIND @ 4 - 5'	100	100	100	99	98	0.053	95	0.038	93	0.019	
01-MSD-58 @ 0'	100	97	91	81	67	0.056	61	0.042	50	0.022	
01-IAM-08 @ 0'	100	58	43	30	22	0.070	20	0.050	18	0.025	
01-MP-82 @ 0'	100	99	97	94	89	0.058	76	0.043	64	0.023	
01-PCA-88 @ 0'	100	91	79	65	54	0.065	48	0.047	39	0.025	
25-IDC-10 @ 0'	100	100	99	98	95	0.054	90	0.039	86	0.020	
25-ODC-108 @ 0 - 2"	100	100	97	91	78	0.058	71	0.043	63	0.022	
01-CP-44 @ 0'	100	99	96	91	85	0.058	75	0.042	71	0.022	
S-98-92 @ 39 - 41'	100	100	100	100	99	0.054	93	0.039	89	0.021	

TABLE I

GRADATION TEST RESULT

JOB NO. 1 473 93

% PASSING MECHANICAL SIEVE											
Sample No.	No. 16	No. 30	No. 50	No. 100	No. 200	Part Diam.	% Pass	Part Diam.	% Pass	Part Diam.	%
S-98-92 @ 34 - 36'	100	100	100	99	96	0.057	82	0.041	77	0.021	
S-97-92 @ 74 - 76'	100	97	96	93	90	0.060	73	0.043	69	0.022	
S-97-92 @ 78 - 81'	100	96	92	87	82	0.060	69	0.044	61	0.023	
S-102-92 @ 39 - 41'	100	100	99	96	93	0.062	58	0.045	50	0.023	
S-102-92 @ 44 - 46'	100	99	98	96	94	0.063	58	0.046	52	0.024	
25-IBA-60 @ 0'	100	61	48	35	25	0.068	24	0.049	17	0.025	
25-WIND @ 9 - 10'	100	99	98	97	95	0.060	72	0.043	66	0.022	
S-100-92 @ 67 - 71'	100	100	99	95	90	0.062	63	0.046	51	0.024	
S-100-92 @ 72 - 74'	100	100	100	98	97	0.057	81	0.042	69	0.022	
S-102-92 @ 29 - 31'	100	98	96	92	89	0.065	50	0.047	41	0.024	
S-102-92 @ 34 - 36'	100	98	95	84	72	0.067	38	0.049	30	0.025	

TABLE I

GRADATION TEST RESULT

JOB NO. 1 473 93

% PASSING MECHANICAL SIEVE											
Sample No.	No. 16	No. 30	No. 50	No. 100	No. 200	Part Diam.	% Pass	Part Diam.	% Pass	Part Diam.	%
S-101-92 @ 44 - 46'	100	99	98	97	96	0.054	91	0.039	88	0.020	
S-101-92 @ 49 - 50'	100	98	94	88	83	0.062	63	0.045	55	0.023	
25-AM-58 @ 9 - 10'	100	99	98	98	95	0.054	89	0.039	85	0.020	
Test Hole (S-93-92) @ 144 - 145.2'	100	100	99	95	65	0.061	64	0.046	45	0.024	
Test Hole (S-93-92) @ 148 - 150'	100	100	100	99	99	0.052	98	0.037	96	0.019	
S-95-92 @ 109 - 111'	100	100	100	99	98	0.053	96	0.038	92	0.020	
S-95-92 @ 129 - 131'	100	98	95	89	85	0.057	82	0.041	78	0.021	
S-96-92 @ 109 - 110'	100	100	100	98	96	0.053	96	0.038	92	0.019	
S-96-92 @ 110 - 111'	100	100	99	89	78	0.058	73	0.042	65	0.022	
S-99-92 @ 34 - 36'	100	94	90	85	81	0.059	75	0.043	71	0.022	

TABLE I

GRADATION TEST RESULT

JOB NO. 1 473 93

% PASSING MECHANICAL SIEVE											
Sample No.	No. 16	No. 30	No. 50	No. 100	No. 200	Part Diam.	% Pass	Part Diam.	% Pass	Part Diam.	%
S-99-92 @ 39 - 40'	100	97	96	93	90	0.057	85	0.042	77	0.022	[illegible]
25-ODC-108 @ 9 - 10'	100	100	99	95	72	0.059	72	0.044	56	0.023	[illegible]
01-IAM-13 @ 0'	100	76	69	62	58	0.064	52	0.046	46	0.024	[illegible]
25-ODC-108 @ 4 - 5'	100	100	100	99	96	0.056	89	0.041	80	0.022	[illegible]

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 4-23-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ____ DEPTH ____ SAMPLE NO. 1 01-TA-30-1 or 2 @ 0'

VISUAL DESCRIPTION: ~~Sandy Clay~~

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ____	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = $\frac{W\%}{W}$ = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.57	48.04	99
50	1.12	47.5	97.78
100	3.04	45.6	93.79
200	7.77	40.8	84.0
PAN			—
TOTAL	48.6		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			55	
WT. WET SOIL AND DISH			27.15	50.00
WT. DRY SOIL AND DISH			26.84	
WT. DISH			15.95	0.00
WT. OF DRY SOIL		= W		48.62
% MOISTURE			2.85	2.846

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (EST.) DISPERSING AGENT ____

DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

4-26

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	START MIX	—	—	—	—		—	—
9:29	STOP MIX	—	—	—	—		—	—
9:29:30	0.5 min.	20.0	42.	5.4	36.6		74.5	0.0508 mm
9:30	1.0 min	20.0	41	5.4	35.6		72.5	0.042 mm
9:33	4.0 min	20.0	35	5.4	29.6		60.3	0.023 mm
9:48	19 min	20.0	31.5	5.4	26.1		53.1	0.068 mm
10:29	60 min	20.	28.0	5.4	22.6		46.0	0.0056 mm
16:29	7h min	22.5	21.0	4.4	16.6		33.9	0.002 mm
11:14	25h 45 min	21.5	16.	4.8	11.2		22.9	0.001 mm

4-27

GRAVEL 0 % SAND 16 % CLAY-SILT 84 %. STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5-10-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. SU

HOLE ____ DEPTH ____ SAMPLE NO. 2 25-AM-58 @0'

VISUAL DESCRIPTION: [redacted]

RUN BY ____ **SAMPLE PREPERATION** SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS

	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____ **SIEVE AND HYDROMETER ANALYSIS** SIEVING TIME ____

FACTOR = W%/W = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0	0	100
30 (~~40~~)	22.52	26.4	54.0
50	29.94	18.9	38.69
100	36.35	12.6	25.76
200	39.90	9.0	18.4
PAN			—
TOTAL	48.9		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			52	
WT. WET SOIL AND DISH			24.86	50
WT. DRY SOIL AND DISH			24.67	—
WT. DISH			16.14	0
WT. OF DRY SOIL		= W	8.53	48.91
% MOISTURE			2.227 →	2.227

RUN BY ____ **HYDROMETER ANALYSIS**

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO3

DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD. CORR.*	CORR READ	FACTOR x CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	8:49	START MIX	—	—	—	—		—	—
4-30	8:50	STOP MIX	—	—	—	—		—	—
	8:50.5	0.5 min.	20	13	5.4	7.6		15.4	0.058 mm
	8:51	1.0 min	20	11.	5.4	5.6		11.3	0.034 mm
	8:54	4.0 min	20	9.5	5.4	4.1		8.3	0.019 mm
	9:09	19 min	20	8.5	5.4	3.1		6.2	0.009 mm
	9:50	60 min	20	8.5	5.4	3.1		6.2	0.0067 mm
	15:50	7h min	21	8.0	5.0	3.0		6.1	0.0023 mm
5-1	10:35	25h 45 min	16.5	9.0	6.9	2.1		4.3	0.001 mm

GRAVEL 0% SAND 82% CLAY-SILT 18% STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 4- -

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 3 01-HBA-84 @01

VISUAL DESCRIPTION: Slightly Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.4	48.48	99.9
50	0.85	47.67	98.2
100	2.24	46.28	95.4
200	3.27	45.25	93.3
PAN			—
TOTAL	~~48.52~~		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			16	
WT. WET SOIL AND DISH			27.18	50.00
WT. DRY SOIL AND DISH			26.83	—
WT. DISH			15.34	0
WT. OF DRY SOIL		= W		48.52
% MOISTURE			3.05 →	3.046

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7(Est.) DISPERSING AGENT 4% Na

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:40	START MIX	—	—	—	—		—	—
9:41	STOP MIX	—	—	—	—		—	—
41:30	0.5 min.	20.0	45.5	5.4	40.1		81.8	0.0507mm
42:00	1.0 min	20.0	41.0	5.4	35.6		72.6	0.0~~37~~ 42 mm
9:45:00	4.0 min	20.0	35.0	5.4	29.6		60.4	0.0~~19~~ 22 mm
10:00	19 min	20.0	30.0	5.4	24.6		50.2	0.00~~9~~ 10 mm
10:41	60 min	20.	21.0	5.4	15.6		31.8	0.00~~5~~ 6 mm
16:41	7h min	22.5	15.	4.4	10.6		21.7	0.002 mm
11:26	25h 46 min	21.5	13	4.8	8.2		16.8	0.001 mm

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GRAVEL 0 % SAND 7 % CLAY-SILT 93 %. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/ -9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. B.

HOLE ______ DEPTH ______ SAMPLE NO. 4 25-WIND @0'

VISUAL DESCRIPTION: Silty Sand

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	18.96	29.6	60.9
50	26.71	21.9	45.0
100	33.49	15.1	31.1
200	36.99	11.6	23.9
PAN			—
TOTAL	48.6		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			58	
WT. WET SOIL AND DISH			26.52	50.00
WT. DRY SOIL AND DISH			26.23	—
WT. DISH			16.14	0
WT. OF DRY SOIL		= W	10.09	48.60
% MOISTURE			2.9	→ 2.874

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	8:55	START MIX	—	—	—	—		—	—
4-30	8:56	STOP MIX	—	—	—	—		—	—
	8:56:30	0.5 min.	20	16	5.4	10.6		21.6	0.070 mm
	8:57	1.0 min	20	14	5.4	8.6		17.5	0.050 mm
	9:00	4.0 min	20	12	5.4	6.6		13.4	0.025 mm
	9:15	19 min	20	10.5	5.4	5.1		10.4	0.006 mm
	9:56	60 min	20	10	5.4	4.6		9.3	0.0061 mm
	15:56	7h min	21	9	5.0	4.0		8.2	0.002 mm
5-1	10:41	25h 45 min	17	10	6.7	3.3		6.8	0.001 mm

GRAVEL 0 % SAND 76 % CLAY-SILT 24 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. 5-10-

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 4-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 5 25-AM-58 @4-5'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
	W% =					

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	1.13	47.4	~~97.7~~ 8
50	2.88	45.66	~~94~~
100	6.19	42.35	~~87.2~~
200	8.31	40.2	82.9
PAN			—
TOTAL	48.54		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			54	
WT. WET SOIL AND DISH			25.19	50
WT. DRY SOIL AND DISH			24.92	—
WT. DISH			15.96	0
WT. OF DRY SOIL		= W		48.54
% MOISTURE			3.01	→ 3.013

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT ______

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:54	START MIX	—	—	—	—		—	—
9:55	STOP MIX	—	—	—	—		—	—
9:55	0.5 min.	20.	45.	5.4	39.6		80.7	0.059 mm
9:56	1.0 min	20	42.0	5.4	36.6		74.6	0.041 mm
9:59	4.0 min	20.	39.0	5.4	33.6		68.5	0.021 mm
10:13	18 min	20.	33.0	5.4	27.6		56.3	0.010 mm
10:55	60 min	20.	27.0	5.4	21.6		44.0	0.006 mm
16:55	7h min	22.5	17.5	4.4	13.1		26.8	0.002 mm
11:40	25h 45 min	21.5	13.5	4.8	8.7		17.8	0.001 mm

4-27

GRAVEL 0 % SAND 17 % CLAY-SILT 83 %. STORAGE LOCATION ______

✱ CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/4-10-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. U

HOLE ______ DEPTH ______ SAMPLE NO. 6 25-CT-07@0'

VISUAL DESCRIPTION: Silty Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W% / W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0	[illegible]	100
30 (~~40~~)	0.13	48.6	~~99.7~~ 100
50	0.27	48.5	99.4
100	0.5	48.24	98.9
200	1.23	47.5	97.5
PAN		—	—
TOTAL	48.74		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			36	
WT. WET SOIL AND DISH			27.66	[illegible]00
WT. DRY SOIL AND DISH			27.35	—
WT. DISH			15.38	0
WT. OF DRY SOIL		= W	11.97	48.74
% MOISTURE			2.590	→ 2.590

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 Est. DISPERSING AGENT 4% NPO3

DISH NO. ______ DATE 4-30-03 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-30	9:03	START MIX	—	—	—	—		—	—
	9:04	STOP MIX	—	—	—	—		—	—
	9:04:30	0.5 min.	20	53	5.4	47.6		96.7	0.052 mm
	9:05	1.0 min	20	50	5.4	44.6		90.6	0.038 mm
	9:08	4.0 min	20	47	5.4	41.6		84.5	0.020 mm
	9:23	19 min	20	42	5.4	36.6		74.3	0.009 mm
	10:04	60 min	20	35	5.4	29.6		60.1	0.005 mm
	16:04	7h min	21	22	5.0	17.0		34.6	0.002 mm
5-1	10:49	25h 45 min	17	18	6.7	11.3		23.0	0.001 mm

GRAVEL 0 % SAND 2 % CLAY-SILT 98 %. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.
GRADATION ANALYSIS
WORKSHEET

LAB NO ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5-10-9
JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ____ DEPTH ____ SAMPLE NO. 7 25-WIND @ 4-5'
VISUAL DESCRIPTION: Silty Clay

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% = ____

SAMPLE WEIGHTS

	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 ~~(40)~~	0.07	48.28	100
50	0.13	48.22	~~99.~~ 100
100	0.26	48.1	99.5
200	0.67	47.7	98.6
PAN			—
TOTAL	48.35		—

FACTOR = $\frac{W\%}{W}$ = ____ = ____

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			49	
WT. WET SOIL AND DISH			25.82	50.00
WT. DRY SOIL AND DISH			25.49	—
WT. DISH			15.85	0
WT. OF DRY SOIL		= W		48.35
% MOISTURE			3.42 →	3.423

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est) DISPERSING AGENT ____
DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

4-26

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
10:07	START MIX	—	—	—	—		—	—
10:08	STOP MIX	—	—	—	—		—	—
10:08.5	0.5 min.	20	52	5.4	46.6		95.4	0.053 mm
10:09	1.0 min	20	51	5.4	45.6		93.4	0.038 mm
10:12	4.0 min	20	49	5.4	43.6		89.3	0.019 mm
10:27	19 min	20	43.5	5.4	38.1		78.0	0.009 mm
11:08	60 min	20.	37.5	5.4	32.1		65.7	0.006 mm
17:08	7h min	22.5	24.0	4.4	19.6		40.2	0.002 mm
11:53	25h 45 min	21.5	17.	4.8	12.2		25.0	0.001 mm

7

GRAVEL 0 % SAND 1 % CLAY-SILT 99 %. STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/4 ...

JOB NAME EBASCO, Tooele Army Depot CALC. BY SU CKED. [redacted]

HOLE ______ DEPTH ______ SAMPLE NO. 8 01-MSD-58@01

VISUAL DESCRIPTION: Slightly Clayey Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (40)	2.14	65.9	96.97
50	5.85	62.2	91.4
100	13.18	54.8	80.61
200	22.45	45.6	67.0
PAN			—
TOTAL	68		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			21	
WT. WET SOIL AND DISH			28.67	[redacted]
WT. DRY SOIL AND DISH			28.30	—
WT. DISH			15.70	0
WT. OF DRY SOIL		______ = W		68.00
% MOISTURE			2.94	→ 2.936

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	
4-26	10:18	START MIX	—	—	—	—		—	—	
	10:22	STOP MIX	—	—	—	—		—	—	
	22:30	0.5 min.	20	47	5.4	41.6		60.5	0.05~~0~~6 mm	
	10:23	1.0 min	"	40	5.4	34.6		50.4	0.03~~7~~ 42 mm	
	10:26	4.0 min	"	31.5	5.4	26.1		38.0	0.0~~15~~ 22 mm	
	10:41	19 min	20.	25.5	5.4	20.1		29.2	0.00~~9~~ 11 mm	
	11:22	60 min	20	21.0	5.4	15.6		22.7	0.00~~5~~6 mm	
	17:22	7h min	22.5	15.0	4.4	10.6		15.5	0.002 mm	
4-27	12:07	25h 45 min	21.5	12.0	4.8	7.2		10.5	0.001 mm	[redacted]

GRAVEL 0% SAND 33% CLAY-SILT 67% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-10-9

JOB NAME EBASCO, Tovelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 9 01-IAM-08 @ 0'

VISUAL DESCRIPTION: Silty Sand

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0	0	
16	0	0	100
30 (~~40~~)	20.58	28.4	58.0
50	27.84	21.2	43.2
100	34.34	14.7	~~29.9~~ 30
200	38.49	10.5	21.5
PAN			—
TOTAL	49.02		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.				
WT. WET SOIL AND DISH			22.65	50.00
WT. DRY SOIL AND DISH			22.41	—
WT. DISH			10.4	0
WT. OF DRY SOIL		______ = W	12.01	49.02
% MOISTURE			~~2.0~~ 1.998 →	1.998

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 Est. DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
5-3 8:52	START MIX	—	—	—	—		—	—
8:53	STOP MIX	—	—	—	—		—	—
8:53.5	0.5 min.	21	15	5.0	10.0		20.2	0.0~~58~~ 58 mm
8:54	1.0 min	21	14	5.0	9.0		18.2	0.0~~2~~ 50 mm
8:57	4.0 min	21	10.5	5.0	5.5		11.1	0.0~~10~~ 25 mm
9:12	19 min	21	9	5.0	4.0		8.1	0.00~~5~~ 12 mm
9:53	60 min	21	8.5	5.0	3.5		7.1	0.00~~5~~ 7 mm
15:53	7h min	22	7.5	4.6	2.9		5.9	0.002 mm
5-4 10:38	25h 45 min	19	8.5	5.8	2.7		5.4	0.001 mm

GRAVEL 0 % SAND 78 % CLAY-SILT 22 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5?-10-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. S

HOLE ______ DEPTH ______ SAMPLE NO. 10 01-MP-82 @0'

VISUAL DESCRIPTION: Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.31	48.7	99.4
50	1.33	47.7	97.3
100	3.17	45.8	93.54
200	5.40	43.6	89.0
PAN			—
TOTAL	49		—

FACTOR = $\frac{W\%}{W}$ = ______ = ______

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			08	
WT. WET SOIL AND DISH			24.19	50
WT. DRY SOIL AND DISH			24.01	—
WT. DISH		/	15.03	0
WT. OF DRY SOIL		= W		49.02
% MOISTURE			2.004 →	2.004

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-26	10:33	START MIX	—	—	—	—		—	—
	10:34	STOP MIX	—	—	—	—		—	—
	10:34:30	0.5 min.	20.	43	5.4	37.6		75.9	0.05~~0~~8 mm
	10:35	1.0 min	20.	37	5.4	31.6		63.8	0.0~~37~~43 mm
	10:38	4.0 min	20	30	5.4	24.6		49.7	0.0~~19~~23 mm
	10:53	19 min	20	21	5.4	15.6		31.5	0.0~~09~~11 mm
	11:34	60 min	20	16.5	5.4	11.1		22.4	0.00~~5~~6 mm
	17:34	7h min	22.5	11.5	4.4	7.1		14.4	0.002 mm
4-27	12:19	25h 45 min	22.0	10.0	4.6	5.4		11.0	0.001 mm

GRAVEL 0 % SAND 11 % CLAY-SILT 89 %. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-10-?

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SV CKED. BY SV

HOLE ______ DEPTH ______ SAMPLE NO. 11 01-PCA-88 @0'

VISUAL DESCRIPTION: Very Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	4.44	49.8	91.0
50	10.51	38.7	~~78.~~79
100	17.29	31.9	64.95
200	22.77	26.4	53.7
PAN			——
TOTAL	~~49.2~~		——

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			62	
WT. WET SOIL AND DISH			24.88	50.00
WT. DRY SOIL AND DISH			24.73	——
WT. DISH			15.61	0
WT. OF DRY SOIL		______ = W		49.19
% MOISTURE			1.645 →	1.645

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7(Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

4-26

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
10:45	START MIX	——	——	——	——		——	——
10:46	STOP MIX	——	——	——	——		——	——
10:46:30	0.5 min.	20	29	5.4	23.6		47.5	0.05~~0~~ 65 mm
10:47	1.0 min	20	25	5.4	19.6		39.4	0.03~~7~~ 47 mm
10:50	4.0 min	20	17.5	5.4	12.1		24.3	0.01~~9~~ 25 mm
11:05	19 min	20	14.	5.4	8.6		17.3	0.00~~9~~ 11 mm
11:46	60 min	20	12.5	5.4	7.1		14.3	0.00~~5~~ 7 mm
17:46	7h min	22.5	10.5	4.4	6.1		12.4	0.002 mm
12:31	25h 45 min	22.0	8.5	4.6	3.9		7.9	0.001 mm

27

GRAVEL 0 % SAND 46 % CLAY-SILT 54 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/[illegible] -[illegible]

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. [illegible]U

HOLE ______ DEPTH ______ SAMPLE NO. 12 25-1DC-10@0'

VISUAL DESCRIPTION: Slightly Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR $F = \frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (40)	.23	48.6	~~99.5~~ 100
50	0.42	48.4	99.1
100	0.95	47.9	98.1
200	2.40	46.4	95.1
PAN			—
TOTAL	48.8		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			57	
WT. WET SOIL AND DISH			27.40	3[illegible].00
WT. DRY SOIL AND DISH			27.13	—
WT. DISH			15.75	0
WT. OF DRY SOIL		= W		48.84
% MOISTURE			2.373	→ 2.373

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-26	11:01	START MIX	—	—	—	—		—	—
	11:02	STOP MIX	—	—	—	—		—	—
	11:02:30	0.5 min.	20	50.	5.4	44.6		90.4	0.054 mm
	11:03	1.0 min	20	48	5.4	42.6		86.3	0.039 mm
	11:06	4.0 min	20	45.	5.4	39.6		80.2	0.0~~15~~ 20 mm
	11:21	19 min	20	42	5.4	36.6		74.2	0.009 mm
	12:02	60 min	20	38	5.4	32.6		66.1	0.006 mm
	18:02	7h min	22.5	29	4.4	24.6		50.0	0.002 mm
4-27	12:47	25h 45 min	22.0	21.5	4.6	16.9		34.3	0.001 mm

GRAVEL 0 % SAND 5 % CLAY-SILT 95 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5-7-9

JOB NAME EBASCO CALC. BY SV CKED. BY SV

HOLE ____ DEPTH ____ SAMPLE NO. 13 25-ODC-108 @ 0-

VISUAL DESCRIPTION: Very Sandy Clay

RUN BY ____

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SIEVING TIME ____

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = W%/W = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0	~~100~~	100
30 (40)	0	~~100~~	100
50	1.44	~~97~~	97
100	4.66	~~90.51~~	91
200	10.86	22.9	77.9
PAN			—
TOTAL	49.18		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			15	
WT. WET SOIL AND DISH			12.98	50.00
WT. DRY SOIL AND DISH			12.79	✓
WT. DISH			1.34	0
WT. OF DRY SOIL		= W	11.45	49.18
% MOISTURE			1.659	→ 1.659

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO_3

DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
5-10	8:33	START MIX	—	—	—	—		—	—
	8:34	STOP MIX	—	—	—	—		—	—
	8:34.5	0.5 min.	21.5	40	4.8	35.2		70.9	0.05~~6~~8 mm
	8:35	1.0 min	21.5	36	4.8	31.2		62.8	0.0~~37~~43 mm
	8:38	4.0 min	21.5	32	4.8	27.2		54.8	0.0~~18~~22 mm
	8:53	19 min	21.5	28	4.8	23.2		46.7	0.0~~08~~10 mm
	9:34	60 min	21.5	26	4.8	21.2		42.7	0.00~~5~~6 mm
	15:34	7h min	22.5	20	4.4	15.6		31.5	0.002 mm
5-11	10:19	25h 45 min	21.5	16	4.8	11.2		22.6	0.001 mm

GRAVEL 0% SAND 22% CLAY-SILT 78%. STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen & Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-[illegible]-[illegible]

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SV CKED. [illegible]

HOLE ______ DEPTH ______ SAMPLE NO. 14 01-CP-44@0'

VISUAL DESCRIPTION: Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~20~~)	.72	47.7	~~98.5~~ 9
50	1.88	46.6	96.~~1~~
100	4.38	44.1	91.~~0~~
200	7.08	41.4	85.4
PAN			—
TOTAL	48.45		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			38	
WT. WET SOIL AND DISH			26.03	[illegible]50
WT. DRY SOIL AND DISH			25.70	—
WT. DISH			15.40	0
WT. OF DRY SOIL		______ = W		48.45
% MOISTURE			3.204	→ 3.204

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-26	11:17	START MIX	—	—	—	—		—	—
	11:18	STOP MIX	—	—	—	—		—	—
	11:18:30	0.5 min.	20.	42	5.4	36.6		74.8	0.05~~6~~8 mm
	11:19	1.0 min	20.	40	5.4	34.6		70.7	0.03~~5~~ 42 mm
	11:22	4.0 min	20	34	5.4	28.6		58.4	0.01~~9~~ 22 mm
	11:37	19 min	20	29	5.4	23.6		48.2	0.0~~09~~ 10 mm
	12:18	60 min	21	24	5.0	19.0		38.8	0.00~~5~~6 mm
	18:18	7h min	22.5	17.0	4.4	12.6		25.8	0.002 mm
4-27	12:52	25h ~~35~~ 34 min	22.0	12.5	4.6	7.9		16.2	0.001 mm

GRAVEL 0 % SAND 15 % CLAY-SILT 85 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

JOB NAME EBASCO, Tooelle Army Depot PREP. BY F.D DATE 5-4-10-

CALC. BY SV CKED. BY SV

HOLE ______ DEPTH ______ SAMPLE NO. 15 S-98-92 @ 39-41'

VISUAL DESCRIPTION: highly plastic Clay

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (~~40~~)	.02	47.6	100
50	.08	47.5	100
100	0.19	47.4	~~99.6~~ 100
200	0.39	47.2	99.2
PAN			—
TOTAL	47.6		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			27	
WT. WET SOIL AND DISH		21.63	21.64	50.00
WT. DRY SOIL AND DISH			21.15	—
WT. DISH			11.67	0
WT. OF DRY SOIL		= W		47.59
% MOISTURE			5.063 →	5.063

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO$_3$

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-26 11:31:00	START MIX	—	—	—	—		—	—
11:33:00	STOP MIX	—	—	—	—		—	—
11:32:30	0.5 min.	20	50	5.4	44.6		92.8	0.054 mm
11:33	1.0 min	20	48	5.4	42.6		88.6	0.039 mm
11:36	4.0 min	20	42	5.4	36.6		76.1	0.021 mm
11:51	19 min	20	35	5.4	29.6		61.5	0.0018 mm
12:32	60 min	21	31.5	5.0	26.5		55.1	0.006 mm
18:32	7h min	22.5	20.5	4.4	16.1		33.6	0.002 mm
-27 13:17	25h ~~38~~ min	22.0	15.	4.6	10.4		21.7	0.001 mm

GRAVEL 0 % SAND 1 % CLAY-SILT 99 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5/10

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. ____

HOLE ____ DEPTH ____ SAMPLE NO. 16 S-98-92 @ 34-36'

VISUAL DESCRIPTION: Slightly Sandy, highly plastic Clay

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = $\frac{W\%}{W}$ = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (~~40~~)	0.02	48.0	100
50	0.10	47.9	~~99.8~~ 100
100	0.52	47.5	~~98.9~~ 99
200	1.79	46.3	96.3
PAN			—
TOTAL	48.05		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			51	
WT. WET SOIL AND DISH			27.11	50.0
WT. DRY SOIL AND DISH			26.65	
WT. DISH			15.34	0
WT. OF DRY SOIL		= W		48.05
% MOISTURE			4.067	4.067

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-26 11:39	START MIX	—	—	—	—		—	—
11:40	STOP MIX	—	—	—	—		—	—
11:40:30	0.5 min.	20	45	5.4	39.6		81.6	0.05~~07~~ mm
11:41	1.0 min	20	43	5.4	37.6		77.4	0.03 41 mm
11:44	4.0 min	20	40	5.4	34.6		71.3	0.01 21 mm
11:59	19 min	20	36	5.4	30.6		63.0	0.009 10 mm
12:40	60 min	20	33	5.0	28.0		57.7	0.005 6 mm
18:40	7h min	22.5	25	4.4	20.6		42.5	0.002 mm
4-27 13:25	25h 45 min	22.0	20	4.6	15.4		31.8	0.001 mm

GRAVEL 0% SAND 4% CLAY-SILT 96%. STORAGE LOCATION ____

✱ CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

JOB NAME EBASCO, Tooelle Army Depot PREP. BY F.D DATE 5/4-10-

CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 17 5-97-92 @ 74-76'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		100
16	0		100
30 (~~40~~)	1.20	46.7	97.5
50	2.05	45.9	~~95~~ 96
100	3.34	44.6	93
200	4.86	43	89.9
PAN			—
TOTAL	47.9		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			36	
WT. WET SOIL AND DISH			26.38	50.00
WT. DRY SOIL AND DISH			25.92	—
WT. DISH			15.36	0
WT. OF DRY SOIL		= W	10.56	47.91
% MOISTURE			4.4 356 →	4.356

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO_3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-28 8:__	START MIX	—	—	—	—		—	—
53	STOP MIX	—	—	—	—		—	—
53:30	0.5 min.	19	41	5.8	35.2		72.7	0.060 mm
54	1.0 min	19	39	5.8	33.2		68.5	0.043 mm
8:57	4.0 min	19	33	5.8	27.2		56.1	0.022 mm
9:12	19 min	19	30	5.8	24.2		49.9	0.011 mm
9:53	60 min	20	25	5.4	19.6		40.5	0.006 mm
15:53	7h min	20	15	5.4	9.6		19.8	0.002 mm
29 __:38	25h 45 min	20	11	5.4	5.6		11.5	0.001 mm

GRAVEL 0% SAND 10% CLAY-SILT 90%. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen-Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY EV CKED. B

HOLE ______ DEPTH ______ SAMPLE NO. 18 5-97-92 @ 78-81'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16	0		100
30 (~~40~~)	1.81	47.2	96.3
50	3.81	45.2	92.2
100	6.49	42.5	86.7
200	8.93	40.0	81.8
PAN			—
TOTAL	48.97		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			38	
WT. WET SOIL AND DISH			25.55	50.00
WT. DRY SOIL AND DISH			25.34	—
WT. DISH			15.40	0
WT. OF DRY SOIL		= W	0.21	48.97
% MOISTURE			2.113 →	2.113

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR x CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-29	9:03	START MIX	—	—	—	—		—	—
	9:04	STOP MIX	—	—	—	—		—	—
	04:30	0.5 min.	19	40	5.8	34.2		69.1	0.0~~8~~60 mm
	9:05	1.0 min	19	36	5.8	30.2		61.0	0.0~~37~~44 mm
	9:08	4.0 min	19	31	5.8	25.2		50.9	0.0~~19~~23 mm
	9:23	19 min	19	25	5.8	19.2		38.7	0.00~~9~~11 mm
	10:04	60 min	20	22	5.4	16.6		33.5	0.00~~8~~6 mm
	16:04	7h min	20	14	5.4	8.6		17.4	0.002 mm
4-29	10:30	25h ~~28~~ min	20	12	5.4	6.6		13.3	0.001 mm

GRAVEL 0 % SAND 18 % CLAY-SILT 82 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen-Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 142393 PART NO. ______ PREP. BY F.D DATE 5-7-9

JOB NAME EBASCO CALC. BY SU CKED. BY SV

HOLE ______ DEPTH ______ SAMPLE NO. 19 S-102-92 @ 39-41'

VISUAL DESCRIPTION: Slightly Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
	W% =					

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (40)	0	~~100~~	100
50	c.26	~~99.5~~	99
100	1.86	~~96.2~~	96
200	3.22	~~93.4~~	93.4
PAN			—
TOTAL	48.~~6~~59		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			16	
WT. WET SOIL AND DISH			12.22	50.00
WT. DRY SOIL AND DISH			11.92	—
WT. DISH			1.59	0
WT. OF DRY SOIL		______ = W	10.33	48.59
% MOISTURE			2.904	→ 2.904

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 5-10-93 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	8:39	START MIX	—	—	—	—		—	—
5-10	8:40	STOP MIX	—	—	—	—		—	—
	8:40.5	0.5 min.	21.5	33	4.8	28.2		57.5	0.0~~55~~ 62 mm
	8:41	1.0 min	21.5	29.5	4.8	24.7		50.4	0.0~~7~~ 45 mm
	8:44	4.0 min	21.5	25.	4.8	20.2		41.2	0.0~~18~~ 23 mm
	8:59	19 min	21.5	22	4.8	17.2		35.1	0.0~~09~~ 11 mm
	9:40	60 min	21.5	19	4.8	14.2		29.0	0.00~~5~~ 6 mm
	15:40	7h min	22.5	14.5	4.4	10.1		20.7	0.002 mm
5-11	10:25	25h 45 min	21.5	11.0	4.8	6.2		12.7	0.001 mm

GRAVEL 0% SAND 7% CLAY-SILT 93%. STORAGE LOCATION ______

✳ CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/4 '92 -

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. ______

HOLE ______ DEPTH ______ SAMPLE NO. 20 5-102-92 @ 44-46

VISUAL DESCRIPTION: Slightly Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16	0		100
30 (~~40~~)	0.32	47.7	~~100~~ 99
50	0.89	47.1	98.1
100	1.78	46.3	96.3
200	2.84	45.2	94.1
PAN			—
TOTAL	48.		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			49	
WT. WET SOIL AND DISH			26.0	50.00
WT. DRY SOIL AND DISH			25.61	—
WT. DISH			15.87	0
WT. OF DRY SOIL		______ = W	9.74	48.03
% MOISTURE			4.107	→ 4.107

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-28	9:19	START MIX	—	—	—	—		—	—
	9:20	STOP MIX	—	—	—	—		—	—
	20:30	0.5 min.	19	34	5.8	28.2		58.1	0.063 mm
	21	1.0 min	19	31	5.8	25.2		51.9	0.046 mm
	9 24	4.0 min	19	26	5.8	20.2		41.6	0.024 mm
	9 39	19 min	19	20	5.8	14.2		29.2	0.011 mm
	10:20	60 min	20	16	5.4	10.6		21.8	0.006 mm
	16:20	7h min	20	11.	5.4	5.6		11.5	0.002 mm
4-29	11:05	25h 45 min	20	9	5.4	3.6		7.4	0.001 mm

GRAVEL 0% SAND 6% CLAY-SILT 94% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen & Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/4-13-93

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 21 25-IBA-60 @ 0'

VISUAL DESCRIPTION: Silty Sand

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	26.53	42.3	61.~~8~~
50	35.60	33.3	48.~~8~~
100	44.79	24.1	3~~4~~5
200	51.91	16.9	24.6
PAN			—
TOTAL	68.~~9~~85		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			49	
WT. WET SOIL AND DISH			28.08	70.00
WT. DRY SOIL AND DISH			27.88	—
WT. DISH			15.86	0
WT. OF DRY SOIL		= W	12.02	68.85
% MOISTURE			1.~~7~~664 →	1.664

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

4-30

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:11	START MIX	—	—	—	—		—	—
9:12	STOP MIX	—	—	—	—		—	—
9:12.5	0.5 min.	20	22.	5.4	16.6		23.8	0.0~~66~~ 68 mm
9:13	1.0 min	20	17	5.4	11.6		16.7	0.0~~4~~ 49 mm
9:16	4.0 min	20	14	5.4	8.6		12.3	0.0~~25~~ 25 mm
9:31	19 min	20	12	5.4	6.6		9.5	0.0~~0~~ 12 mm
10:21	6~~0~~ 9 min	20	10.5	5.4	5.1		7.3	0.00~~7~~ 6 mm
16:12	7h min	21	9.5	5.0	4.5		6.5	0.002 mm
10:57	25h 45 min	17	10.5	6.7	3.8		5.5	0.001 mm

GRAVEL 0% SAND 75% CLAY-SILT 25%. STORAGE LOCATION ______

✱ CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5/4 '10 -

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. ____

HOLE ____ DEPTH ____ SAMPLE NO. 22 25-WIND @ 9-10'

VISUAL DESCRIPTION: Slightly Sandy Clay

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SAMPLE WEIGHTS

	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = W%/W = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16	0		100
30 (~~40~~)	0.54	47.7	99
50	1.01	47.3	98
100	1.65	48.7	~~96.6~~ 97
200	2.41	45.9	95.0
PAN			—
TOTAL	48.325		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			36	
WT. WET SOIL AND DISH			25.38	50.00
WT. DRY SOIL AND DISH			25.03	
WT. DISH			15.38	0
WT. OF DRY SOIL		= W	9.65	48.25
% MOISTURE			3.627 →	3.627

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO3

DISH NO. ____ DATE ____ AMOUNT ____ ml DATE CALIB. ____

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-28	9:29	START MIX	—	—	—	—		—	—
	9:30	STOP MIX	—	—	—	—		—	—
	9:30.5	0.5 min.	18	41	5.8	35.2		72.1	0.060 mm
	9:31	1.0 min	19	38	5.8	32.2		66.0	0.043 mm
	9:34	4.0 min	19	33.5	5.8	27.7		56.8	0.022 mm
	9:49	19 min	19	29	5.8	23.2		47.5	0.011 mm
	10:30	60 min	20	24.5	5.4	19.1		39.2	0.006 mm
	16:30	7h min	20	16	5.4	10.6		21.7	0.002 mm
4-29	11:15	25h 45 min	20	12	5.4	6.6		13.5	0.001 mm

GRAVEL 0 % SAND 5 % CLAY-SILT 95 % STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO

JOB NO. 147393 PART NO. PREP. BY F.D DATE 4-10-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE DEPTH SAMPLE NO. 23 S-100-92 @ 67-71'

VISUAL DESCRIPTION: Slightly Sandy Silt

RUN BY

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SIEVING TIME

SAMPLE WEIGHTS

	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME

FACTOR = $\frac{W\%}{W}$ = =

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16			
30 (~~40~~)	.09	47.3	100
50	0.54	46.83	~~98.9~~ 99
100	2.41	44.9	~~94.9~~ 95
200	4.76	42.6	90.0
PAN			—
TOTAL	47.4		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			27	
WT. WET SOIL AND DISH			21.55	50.00
WT. DRY SOIL AND DISH			21.03	—
WT. DISH			11.67	0
WT. OF DRY SOIL		= W	9.36	47.37
% MOISTURE			5.~~6~~556 →	5.556

RUN BY

HYDROMETER ANALYSIS

CYLINDER NO. SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. DATE AMOUNT ml DATE CALIB.

4-28

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:35	START MIX	—	—	—	—		—	—
9:36	STOP MIX	—	—	—	—		—	—
9:36.5	0.5 min.	19	36	5.8	30.2		63.0	0.0~~58~~ mm
9:37	1.0 min	19	30	5.8	24.2		50.5	0.0~~37~~ 36 mm
9:40	4.0 min	19	24	5.8	18.2		38.0	0.0~~15~~ 24 mm
9:55	19 min	19	18.5	5.8	12.7		26.5	0.00~~9~~ 11 mm
10:36	60 min	20	15.	5.4	9.6		20.0	0.00~~5~~ 6 mm
16:36	7h min	20	11.	5.4	5.6		11.7	0.002 mm
29 11:21	25h 45 min	20	8	5.4	2.6		5.4	0.001 mm

GRAVEL 0 % SAND 10 % CLAY-SILT 90 %. STORAGE LOCATION

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: SUPERVISOR:

L-4 (5-85) LOCATION:

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5/ 0-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. B

HOLE ______ DEPTH ______ SAMPLE NO. 24 S-100-92 @ 72-74

VISUAL DESCRIPTION: Slightly Sandy, highly Plastic Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16			
30 (~~40~~)	.01	48.9	100
50	0.19	48.7	100
100	.98	47.89	98.0
200	1.66	47.2	96.6
PAN			—
TOTAL	48.9		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			21	
WT. WET SOIL AND DISH			22.33	50.00
WT. DRY SOIL AND DISH			22.18	—
WT. DISH			15.7	0
WT. OF DRY SOIL		= W	6.48	48.87
% MOISTURE			2.315	→ 2.315

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% Na PO_3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-28	9:46	START MIX	—	—	—	—		—	—
	9:47	STOP MIX	—	—	—	—		—	—
	9:47.5	0.5 min.	19	46	5.8	40.2		81.4	0.050 mm
	9:48	1.0 min	19	40	5.8	34.2		69.2	0.032 mm
	9:51	4.0 min	19	35	5.8	29.2		59.1	0.019 mm
	10:06	19 min	20	31.5	5.4	26.1		52.8	0.009 mm
	10:47	60 min	20	28	5.4	22.6		45.8	0.006 mm
	16:47	7h min	20	20	5.4	14.6		29.6	0.002 mm
4-29	11:32	25h 45 min	20	14.5	5.4	9.1		18.4	0.001 mm

GRAVEL 0% SAND 3% CLAY-SILT 97% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-4-10-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 25 S-102-92 @ 29-31'

VISUAL DESCRIPTION: Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)		~~0~~	
16	0	~~0~~	100
30 (~~40~~)	0.98	47.4	98.0
50	2.17	46.2	~~95.5~~ 95.6
100	3.94	44.4	~~96.2~~ 91.2
200	5.28	43.1	89.1
PAN			—
TOTAL	48.35		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			51	
WT. WET SOIL AND DISH			28.34	50.00
WT. DRY SOIL AND DISH			27.91	
WT. DISH			15.34	0
WT. OF DRY SOIL		= W	12.57	48.35
% MOISTURE			3.421	→ 3.421

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

4-28

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:58	START MIX	—	—	—	—		—	—
9:59	STOP MIX	—	—	—	—		—	—
9:59.5	0.5 min.	19	30	5.8	24.2		49.5	0.0~~50~~65 mm
10:00	1.0 min	19	26	5.8	20.2		41.3	0.0~~37~~47 mm
10:03	4.0 min	20	21.5	5.4	16.1		32.9	0.0~~19~~24 mm
10:15	16 ~~15~~ min	20	18	5.4	12.6		25.8	0.0~~08~~12 mm
10:59	60 min	20	16	5.4	10.6		21.7	0.00~~5~~6 mm
16:59	7h min	20	12	5.4	6.6		13.5	0.002 mm
11:44	25h 45 min	20	9	5.4	3.6		7.3	0.001 mm

9

GRAVEL 0 % SAND 11 % CLAY-SILT 89 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen & Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-10-9[illegible]

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED BY ______

HOLE ______ DEPTH ______ SAMPLE NO. 26 S-102-92 @ 34-36'

VISUAL DESCRIPTION: Very Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)			
16		0	100
30 (~~40~~)	0.80	47.4	98.3
50	2.61	45.6	94.5
100	7.62	40.6	84.2
200	13.29	34.9	72.4
PAN			—
TOTAL	48.2		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			62	
WT. WET SOIL AND DISH			27.99	[illegible]0.00
WT. DRY SOIL AND DISH			27.54	—
WT. DISH			15.61	0
WT. OF DRY SOIL		______ = W	11.93	48.18
% MOISTURE			3.8	→ 3.772

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE ______ AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-28	10:06	START MIX	—	—	—	—		—	—
	10:07	STOP MIX	—	—	—	—		—	—
	10:07.5	0.5 min.	20	24	5.4	18.6		38.2	0.0~~56~~67 mm
	10:08	1.0 min	20	20	5.4	14.6		30.0	0.0~~37~~49 mm
	10:11	4.0 min	20	16	5.4	10.6		21.8	0.0~~19~~35 mm
	10:26	19 min	20	13	5.4	7.6		15.6	0.0~~65~~67 mm
	11:07	60 min	20	11	5.4	5.6		11.5	0.00~~5~~7 mm
	17:07	7h min	20	9.5	5.4	4.1		8.4	0.00~~2~~3 mm
4-29	11:52	25h 45 min	20	7	5.4	1.6		3.3	0.001 mm

GRAVEL 0% SAND 28% CLAY-SILT 72% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

JOB NAME EBASCO, Tooelle Army Depot PREP. BY F.D DATE 5/4-13-

CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 27 S-101-92 @ 44-46

VISUAL DESCRIPTION: Silty Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.39	47.4	99
50	0.78	47.0	98
100	1.40	46.4	97
200	2.08	45.7	95.6
PAN			—
TOTAL	47.76		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			21	
WT. WET SOIL AND DISH			32.46	50.00
WT. DRY SOIL AND DISH			31.71	—
WT. DISH			15.70	0
WT. OF DRY SOIL		= W	16.01	47.76
% MOISTURE			4.685 → 4.685	

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:24	START MIX	—	—	—	—		—	—
9:25	STOP MIX	—	—	—	—		—	—
9:25:10	0.5 min.	20	49.5	5.4	44.1		91.4	0.054 mm
9:26	1.0 min	20	48	5.4	42.6		88.3	0.039 mm
9:29	4.0 min	20	46	5.4	40.6		84.1	0.020 mm
9:44	19 min	20	43.5	5.4	38.1		78.9	0.009 mm
10:25	60 min	20	39	5.4	33.6		69.6	0.005 mm
16:25	7h min	21	28	5.0	23.0		47.7	0.002 mm
11:10	25h 45 min	17	24	6.7	17.3		35.9	0.001 mm

GRAVEL 0 % SAND 4 % CLAY-SILT 96 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 6 -

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY

HOLE ______ DEPTH ______ SAMPLE NO. 28 S-101-92 @ 49-50

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.79	45.5	98.3
50	2.57	43.7	94.4
100	5.42	40.9	88.3
200	7.85	38.4	83.0
PAN			—
TOTAL	46.329		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			62	
WT. WET SOIL AND DISH			29.90	100
WT. DRY SOIL AND DISH			28.84	
WT. DISH			15.62	0
WT. OF DRY SOIL		= W	13.22	46.29
% MOISTURE			8.018	→ 8.018

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	% OF TOTAL PASSING	PARTICLE DIAMETER
	9:35	START MIX	—	—	—	—		
4-30	9:36	STOP MIX	—	—	—	—		
	9:36.5	0.5 min.	20	35	5.4	29.6	63.3	0.062 mm
	9:37	1.0 min	20	31	5.4	25.6	54.7	0.045 mm
	9:40	4.0 min	20	26	5.4	20.6	44.0	0.023 mm
	9:55	19 min	20	22	5.4	16.6	35.5	0.011 mm
	10:36	60 min	21	20	5.0	15.0	32.1	0.006 mm
	16:36	7h min	21	14	5.0	9.0	19.3	0.002 mm
5-1	11:22	25h 46 min	17	13	6.7	6.3	13.5	0.001 mm

FACTOR X CORRECTED READING = % OF TOTAL PASSING

GRAVEL 0 % SAND 17 % CLAY-SILT 83 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

PREP. BY F.D DATE 5-13-9

JOB NAME EBASCO, Tooelle Army Depot

CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 29 25-AM-58 @ 9-10'

VISUAL DESCRIPTION: Slightly Sandy, Silty Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SAMPLE WEIGHTS

	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.66	48.2	~~98.79~~ 99
50	0.87	48.0	98
100	1.22	47.7	~~92.58~~ 98
200	2.56	46.3	94.8
PAN			—
TOTAL	48.~~9~~89		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			55	
WT. WET SOIL AND DISH			31.79	50.00
WT. DRY SOIL AND DISH			31.44	✓
WT. DISH			15.97	0
WT. OF DRY SOIL		______ = W	15.47	48.89
% MOISTURE			2.~~3~~262 →	2.262

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
5-3	9:12	START MIX	—	—	—	—		—	—
	9:13	STOP MIX	—	—	—	—		—	—
	9:13.5	0.5 min.	21	49	5.0	44.0		89.1	0.05~~4~~4 mm
	9:14	1.0 min	21	47	5.0	42.0		85.1	0.03~~7~~9 mm
(9:17)	9:18	4.0 min	21	43	5.0	38.0		77.0	0.0~~19~~20 mm
	9:32	19 min	21	35	5.0	30.0		60.8	0.00~~9~~10 mm
	10:12	60 min	21	28	5.0	23.0		46.6	0.00~~5~~6 mm
(16:13)	16:13	7h min	22	16.5	4.6	11.9		24.2	0.002 mm
5-4	10:58	25h 45 min	20	13.0	5.4	7.6		15.4	0.001 mm

GRAVEL 0 % SAND 5% CLAY-SILT 95 %. STORAGE LOCATION ______

✱ CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 5~~4~~-13-

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. ____

HOLE ____ DEPTH ____ SAMPLE NO. 30 Test Hole (S-93-92) @ 14 145.

VISUAL DESCRIPTION: Very Sandy Clay

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE	-	3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = W% / W = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.05	48.3	100
50	0.32	48	99
100	2.41	45.9	95
200	16.93	31.4	65.0
PAN			—
TOTAL	48.32		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			49	
WT. WET SOIL AND DISH			28.93	
WT. DRY SOIL AND DISH			28.49	—
WT. DISH			15.87	0
WT. OF DRY SOIL		= W	12.62	48.32
% MOISTURE			3.487 → 3.487	

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ____ DATE 5-03-93 AMOUNT ____ ml DATE CALIB. ____

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
5-3	9:02	START MIX	—	—	—	—		—	—
	9:03	STOP MIX	—	—	—	—		—	—
	9:03.5	0.5 min.	21	36	5.0	31.0		63.5	0.0~~58~~61 mm
	9:04	1.0 min	21	27	5.0	22.0		45.1	0.0~~47~~46 mm
	9:07	4.0 min	21	20	5.0	15.0		30.8	0.0~~17~~24 mm
	9:22	19 min	21	16	5.0	11.0		22.6	0.0~~08~~11 mm
	10:03	60 min	21	15	5.0	10.0		20.5	0.00~~5~~6 mm
	16:03	7h min	22	12	4.6	7.4		15.2	0.002 mm
5-4	10:47	25h 45 min	20	11.5	5.4	6.1		12.5	0.001 mm

GRAVEL 0 % SAND 35 % CLAY-SILT 65 % STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen-Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______
PREP. BY F.D DATE 5-13-93
JOB NAME EBASCO, Tooelle Army Depot
CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 31 Test Hole (S-93-92) @ 148-150'
VISUAL DESCRIPTION: Slightly Silty Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
	W% =					

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (40)	0.12	47.5	~~99.7~~ 100
50	0.20	47.4	~~99.6~~ 100
100	0.28	47.3	99.4
200	0.40	47.2	99.2
PAN			—
TOTAL	47.62		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			62	
WT. WET SOIL AND DISH			25.91	50.00
WT. DRY SOIL AND DISH			25.02	—
WT. DISH			15.62	0
WT. OF DRY SOIL		= W	9.8	47.62
% MOISTURE			5.000	→ 5.000

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$
DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
5-3 9:22	START MIX	—	—	—	—		—	—
9:23	STOP MIX	—	—	—	—		—	—
9:23.5	0.5 min.	21	52	5.0	47.0		97.7	0.052 mm
9:24	1.0 min	21	51	5.0	46.0		95.7	0.037 mm
9:27	4.0 min	21	50.5	5.0	45.5		94.6	0.019 mm
9:42	19 min	21	45	5.0	40.0		83.2	0.009 mm
10:24	60 min	21	38	5.0	33.0		68.6	0.005 mm
16:24	7h 01 min	22	28	4.6	23.4		48.7	0.002 mm
5-4 11:08	25h 45 min	20	23.5	5.4	18.1		37.6	0.001 mm

GRAVEL 0 % SAND 1 % CLAY-SILT 99 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-3-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SV CKED. BY

HOLE ______ DEPTH ______ SAMPLE NO. 32 S-95-92 @ 109-111'

VISUAL DESCRIPTION: Silty, highly plastic Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (~~40~~)	0		100
50	0.05	47.6	100
100	0.24	47.4	99.~~8~~
200	0.95	46.7	98.0
PAN			—
TOTAL	47.62		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			27	
WT. WET SOIL AND DISH			23.44	50.00
WT. DRY SOIL AND DISH			22.88	—
WT. DISH			11.66	0
WT. OF DRY SOIL		= W	11.22	47.62
% MOISTURE			~~5.0~~ 4.991 →	4.991

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 5-03-03 AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:30	START MIX	—	—	—	—		—	—
9:31	STOP MIX	—	—	—	—		—	—
9:31.5	0.5 min.	21	51	5.0	46.0		95.6	0.05~~6~~3 mm
9:32	1.0 min	21	49	5.0	44.0		91.5	0.03~~7~~8 mm
9:35	4.0 min	21	45	5.0	40.0		83.2	0.020 mm
9:50	19 min	21	40	5.0	35.0		72.8	0.010 mm
10:31	60 min	21	36.5	5.0	31.5		65.5	0.00~~5~~6 mm
16:31	7h min	22	29	4.6	24.4		50.8	0.002 mm
11:16	25h 45 min	20	13	5.4	7.6		15.8	0.001 mm

5-3

5-4

GRAVEL 0% SAND 2% CLAY-SILT 98 %. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen & Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-13-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 33 5-95-92 @ 129-131'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
	W% = ______					

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE	______	______
RETAINED ON NO. 4	______	______
PASSING NO. 4	______	______

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.84	45.2	98
50	2.22	43.8	95
100	4.85	41.2	89
200	6.97	39.1	84.9
PAN			—
TOTAL	46.03		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			09	
WT. WET SOIL AND DISH			30.26	50.00
WT. DRY SOIL AND DISH			29.11	—
WT. DISH			15.79	0
WT. OF DRY SOIL		______ = W	13.32	46.03
% MOISTURE			8.634 →	8.634

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

5-3

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:40	START MIX	—	—	—	—		—	—
9:41	STOP MIX	—	—	—	—		—	—
9:41.5	0.5 min.	21	43	5.0	36.0		81.8	0.057 mm
9:42	1.0 min	21	41	5.0	36.0		77.5	0.041 mm
9:45	4.0 min	21	38	5.0	33.0		71.0	0.021 mm
10:00	19 min	21	34.5	5.0	29.5		63.5	0.010 mm
10:41	60 min	21	26	5.0	21.0		45.2	0.006 mm
16:41	7h min	22	10	4.6	5.4		11.7	0.002 mm
11:26	25h 45 min	20	9	5.4	3.6		7.7	0.001 mm

5"

GRAVEL 0% SAND 15% CLAY-SILT 85%. STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-13-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. ______

HOLE ______ DEPTH ______ SAMPLE NO. 34 S-96-92 @ 109-110'

VISUAL DESCRIPTION: highly plastic Clay

RUN BY ______

SAMPLE PREPERATION

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SIEVING TIME ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (~~40~~)	0	47.7	100
50	0.04	47.7	100
100	0.82	46.9	98.3
200	1.72	45.9	96.4
PAN			—
TOTAL	47.~~7~~68		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			51	
WT. WET SOIL AND DISH			25.46	
WT. DRY SOIL AND DISH			24.99	—
WT. DISH			15.35	0
WT. OF DRY SOIL		= W	9.64	47.68
% MOISTURE			~~4.9~~ 4.876 →	4.876

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
9:50	START MIX	—	—	—	—		—	—
9:51	STOP MIX	—	—	—	—		—	—
9:51.5	0.5 min.	21	51	5.0	46.0		95.5	0.05~~0~~3 mm
9:52	1.0 min	21	49.5	5.0	44.5		92.4	0.03~~7~~8 mm
9:55	4.0 min	21	47	5.0	42.0		87.2	0.019 mm
10:10	19 min	21	42	5.0	37.0		76.9	0.009 mm
10:51	60 min	21	37	5.0	32.0		66.5	0.005 mm
16:51	7h min	22	26	4.6	21.4		44.5	0.002 mm
11:36	25h 45 min	20	19	5.4	13.6		28.2	0.001 mm

5-4

GRAVEL 0% SAND 4% CLAY-SILT 96% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-13-9[illegible]

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SV

HOLE ______ DEPTH ______ SAMPLE NO. ~~35~~ S-96-92 @ 110-111'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% = ______

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (40)	0.11	48.8	~~99.8~~ 100
50	0.44	48.4	99.1
100	5.24	43.6	89.3
200	10.58	38.3	78.3
PAN			—
TOTAL	48.86		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			58	
WT. WET SOIL AND DISH			25.39	50.00
WT. DRY SOIL AND DISH			25.18	—
WT. DISH			16.16	0
WT. OF DRY SOIL		= W	9.02	48.86
% MOISTURE			2.328	→ 2.328

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

5-3

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
10:00	START MIX	—	—	—	—		—	—
10:01	STOP MIX	—	—	—	—		—	—
10:01.5	0.5 min.	21	41	5.0	36.0		73.0	0.058 mm
10:02	1.0 min	21	37	5.0	32.0		64.9	0.042 mm
10:05	4.0 min	21	31	5.0	26.0		52.7	0.022 mm
10:20	19 min	21	27	5.0	22.0		44.6	0.011 mm
11:01	60 min	21	24	5.0	19.0		38.5	0.006 mm
17:01	7h min	22	18.5	4.6	13.9		28.2	0.002 mm
11:46	25h 45 min	20	5	5.4	9.6		19.4	0.001 mm

5-4

GRAVEL 0% SAND 22% CLAY-SILT 78% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

PREP. BY F.D DATE 5/1 13-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY

HOLE ______ DEPTH ______ SAMPLE NO. 36 S-99-92 @ 34-36'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	2.52	43.1	94
50	4.71	40.9	~~89.7~~ 90
100	6.92	38.7	85
200	8.60	37.0	81.1
PAN			—
TOTAL	45.60		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			55	
WT. WET SOIL AND DISH			31.41	[illegible]
WT. DRY SOIL AND DISH			30.05	—
WT. DISH			15.95	0
WT. OF DRY SOIL		___ = W	14.1	45.60
% MOISTURE			9.645	→ 9.645

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% $NaPO_3$

DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	PARTICLE DIAMETER
4-30	9:45	START MIX	—	—	—	—	—	—
	9:46	STOP MIX	—	—	—	—	—	—
	9:46.5	0.5 min.	20	40	5.4	34.6	75.1	0.059 mm
	9:47	1.0 min	20	38	5.4	32.6	70.7	0.043 mm
	9:50	4.0 min	20	35	5.4	29.6	64.2	0.022 mm
	10:05	19 min	20	30	5.4	24.6	53.4	0.010 mm
	10:46	60 min	21	27	5.0	22.0	47.8	0.006 mm
	16:46	7h min	21	20	5.0	15.0	32.6	0.002 mm
5-1	11:31	25h 45 min	17	18	6.7	11.3	24.6	0.001 mm

GRAVEL 0 % SAND 19 % CLAY-SILT 81 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.
GRADATION ANALYSIS
WORKSHEET

LAB NO. ____

JOB NO. 147393 PART NO. ____ PREP. BY F.D DATE 58-13-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ____ DEPTH ____ SAMPLE NO. 37 S-99-92 @ 39-40'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ____

SAMPLE PREPERATION

SIEVING TIME ____

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ____

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ____

FACTOR = $\frac{W\%}{W}$ = ____ = ____

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	1.2	44.9	97.~~4~~
50	1.92	44.1	95.~~8~~6
100	3.11	42.9	93.~~2~~
200	4.67	41.4	89.9
PAN			——
TOTAL	46.~~1~~05		——

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			27	
WT. WET SOIL AND DISH			26.37	50.00
WT. DRY SOIL AND DISH			25.21	—
WT. DISH			11.67	0
WT. OF DRY SOIL		= W	13.54	46.05
% MOISTURE			8.~~6~~567	→ 8.567

RUN BY ____

HYDROMETER ANALYSIS

CYLINDER NO. ____ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ____ DATE 4-30-93 AMOUNT ____ ml DATE CALIB. ____

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
4-30	10:06	START MIX	——	——	——	——		——	——
	10:07	STOP MIX	——	——	——	——		——	——
	10:07.5	0.5 min.	20	45	5.4	39.6		85.1	0.05~~0~~7 mm
	10:08	1.0 min	20	41	5.4	35.6		76.5	0.0~~37~~42 mm
	10:11	4.0 min	20	36	5.4	30.6		65.8	0.0~~19~~22 mm
(10:26)	10:26	19 min	20	31	5.4	25.6		55.0	0.0~~09~~10 mm
(11:07)	11:07	60 min	20	27	5.0	22.0		47.3	0.00~~5~~6 mm
(17:07)	17:07	7h min	21	20	5.0	15.0		32.3	0.002 mm
	11:52	25h 45 min	17	17	6.7	10.3		22.2	0.001 mm

GRAVEL 0 % SAND 10 % CLAY-SILT 90 % STORAGE LOCATION ____

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ____ SUPERVISOR: ____

L-4 (5-85) LOCATION: ____

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-3-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY

HOLE ______ DEPTH ______ SAMPLE NO. 38 25-ODC-108 @ 9-10'

VISUAL DESCRIPTION: Sandy Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
						W% =

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		
30 (~~40~~)	0.12	48.0	~~99.8~~ 100
50	0.25	47.9	99.5
100	2.33	45.8	95.2
200	13.27	34.8	72.4
PAN			——
TOTAL	48.10		——

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			21	
WT. WET SOIL AND DISH			30.97	50.00
WT. DRY SOIL AND DISH			30.39	——
WT. DISH			15.70	0
WT. OF DRY SOIL		= W	14.69	48.10
% MOISTURE			3.948	→ 3.948

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO$_3$

DISH NO. ______ DATE 5-03-93 AMOUNT ______ ml DATE CALIB. ______

	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	10:10	START MIX	——	——	——	——		——	——
5-3	10:11	STOP MIX	——	——	——	——		——	——
	10:11.5	0.5 min.	21	40	5.0	35.0		72.1	0.0500 mm
	10:12	1.0 min	21	32	5.0	27.0		55.6	0.034 mm
	10:15	4.0 min	21	24	5.0	19.0		39.1	0.023 mm
	10:30	19 min	21	20	5.0	15.0		30.9	0.011 mm
	11:11	60 min	21	18	5.0	13.0		26.8	0.006 mm
	17:11	7h min	22	15	4.6	10.4		21.5	0.002 mm
5-4	11:56	25h 45 min	20	13	5.4	7.6		15.6	0.001 mm

GRAVEL 0 % SAND 28 % CLAY-SILT 72 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

JOB NO. 147393 PART NO. ______ LAB NO ______

PREP. BY F.D DATE 5-4-13-9

JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. BY SU

HOLE ______ DEPTH ______ SAMPLE NO. 39 01-1AM-13 @0'

VISUAL DESCRIPTION: Very Sandy Silt

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% = ______	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = $\frac{W\%}{W}$ = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	11.53	37.3	76.4
50	15.01	33.8	69.2
100	18.57	30.2	61.9
200	20.69	28.1	57.6
PAN			—
TOTAL	48.79		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. MOISTURE	HYDRO. SAMPLE
DISH NO.			09	
WT. WET SOIL AND DISH			26.12	50.00
WT. DRY SOIL AND DISH			25.87	—
WT. DISH			15.78	0
WT. OF DRY SOIL		= W	10.09	48.79
% MOISTURE			2.478	→ 2.478

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est.) DISPERSING AGENT 4% NaPO3

DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

4-30

CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	= FACTOR X CORRECTED READING	% OF TOTAL PASSING	PARTICLE DIAMETER
10:12	START MIX	—	—	—	—		—	—
10:13	STOP MIX	—	—	—	—		—	—
10:13.5	0.5 min.	20	31	5.4	25.6		51.9	0.054 mm
10:14	1.0 min	20	28	5.4	22.6		45.8	0.036 mm
10:17	4.0 min	20	24	5.4	18.6		37.7	0.024 mm
10:32	19 min	20	19.5	5.4	14.1		28.6	0.011 mm
11:13	60 min	21	16.	5.0	11.0		22.3	0.006 mm
17:13	7h min	21	11	5.0	6.0		12.2	0.002 mm
11:58	25h 45 min	17	11.	6.7	4.3		8.8	0.001 mm

GRAVEL 0% SAND 42% CLAY-SILT 58% STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______

Chen Northern, Inc.

GRADATION ANALYSIS

WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY F.D DATE 5-13-9
JOB NAME EBASCO, Tooelle Army Depot CALC. BY SU CKED. [redacted]

HOLE ______ DEPTH ______ SAMPLE NO. 40 25-OD C-108 @ 4-5'
VISUAL DESCRIPTION: highly plastic Clay

RUN BY ______

SAMPLE PREPERATION

SIEVING TIME ______

SIEVE SIZE		3"	1 1/2"	3/4"	3/8"	NO.4
OF PAN AND SAMPLE						
WT. OF PAN						
DRY WT. RETAINED						
DRY WT. PASSING						
% OF TOTAL PASSING						
					W% =	

SAMPLE WEIGHTS	WET	DRY
TOTAL SAMPLE		
RETAINED ON NO. 4		
PASSING NO. 4		

RUN BY ______

SIEVE AND HYDROMETER ANALYSIS

SIEVING TIME ______

FACTOR = W%/W = ______ = ______

SIEVE NO.	WEIGHT RETAINED	WEIGHT PASSING	% OF TOTAL PASSING
8 (10)	0		
16	0		100
30 (~~40~~)	0.13	46.2	~~99.7~~ 100
50	0.22	46.1	~~99.5~~ 100
100	0.44	45.9	99.1
200	1.75	44.6	96.2
PAN			—
TOTAL	46.32		—

MOISTURE DETERMINATION

	+4 MATERIAL	-4 MATERIAL	HYGRO. ~~MOISTURE~~	HYDRO. SAMPLE
DISH NO.			51	
WT. WET SOIL AND DISH			36.14	[redacted]
WT. DRY SOIL AND DISH			34.61	—
WT. DISH			15.35	0
WT. OF DRY SOIL		= W	19.26	46.32
% MOISTURE			7.944 → 7.944	

RUN BY ______

HYDROMETER ANALYSIS

CYLINDER NO. ______ SPECIFIC GRAVITY 2.7 (Est) DISPERSING AGENT 4% NaPO3
DISH NO. ______ DATE 4-30-93 AMOUNT ______ ml DATE CALIB. ______

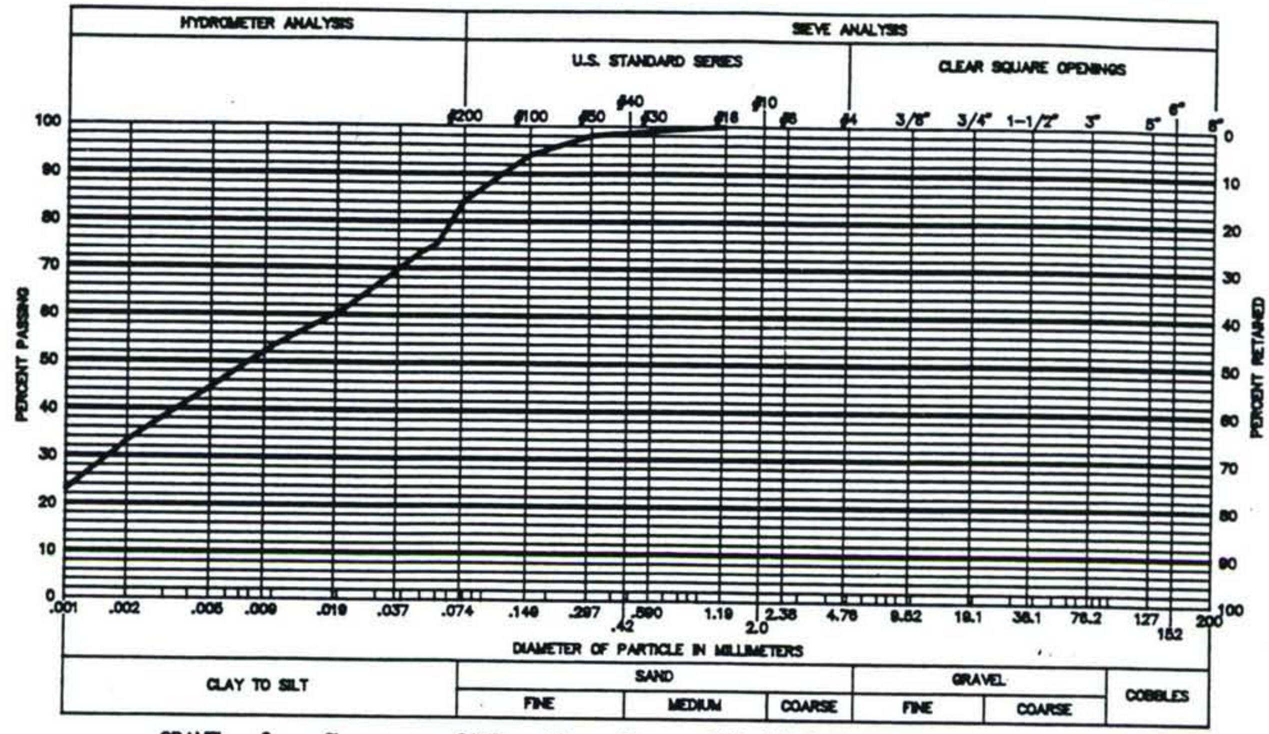
	CLOCK TIME	TEST TIME	TEMP. C°	HYD. READ	HYD.* CORR	CORR READ	FACTOR X CORRECTED READING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER
	10:22	START MIX	—	—	—	—		—	—
4-30	10:23	STOP MIX	—	—	—	—		—	—
	10:23.5	0.5 min.	20	47	5.4	41.6		88.9	0.05~~8~~6 mm
	10:24	1.0 min	20	43	5.4	37.6		80.3	0.0~~37~~41 mm
	10:27	4.0 min	20	36	5.4	30.6		65.4	0.0~~19~~22 mm
	10:42	19 min	20	33	5.4	27.6		59.0	0.0~~08~~10 mm
	11:23	60 min	21	30	5.0	25.0		53.5	0.00~~5~~6 mm
	17:23	7h min	21	27	5.0	22.0		47.0	0.002 mm
5-1	12:08	25h 45 min	17	24	6.7	17.3		37.0	0.001 mm

GRAVEL 0 % SAND 4 % CLAY-SILT 96 % STORAGE LOCATION ______

* CORRECTION INCLUDES TEMP., MENISCUS, AND DEFLOCULENT

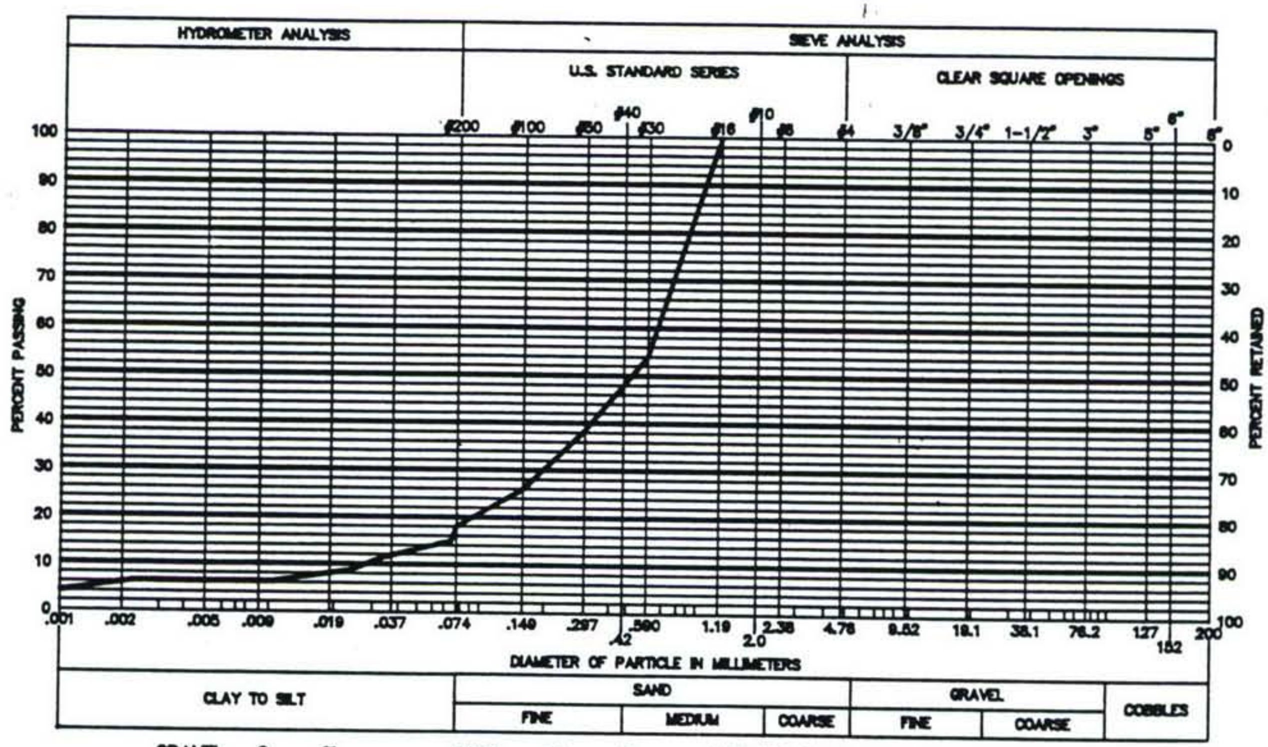
DATE IN: ______ SUPERVISOR: ______

L-4 (5-85) LOCATION: ______



GRAVEL 0 % SAND 16 % SILT AND CLAY 84 %
LIQUID LIMIT 39 PLASTICITY INDEX 19

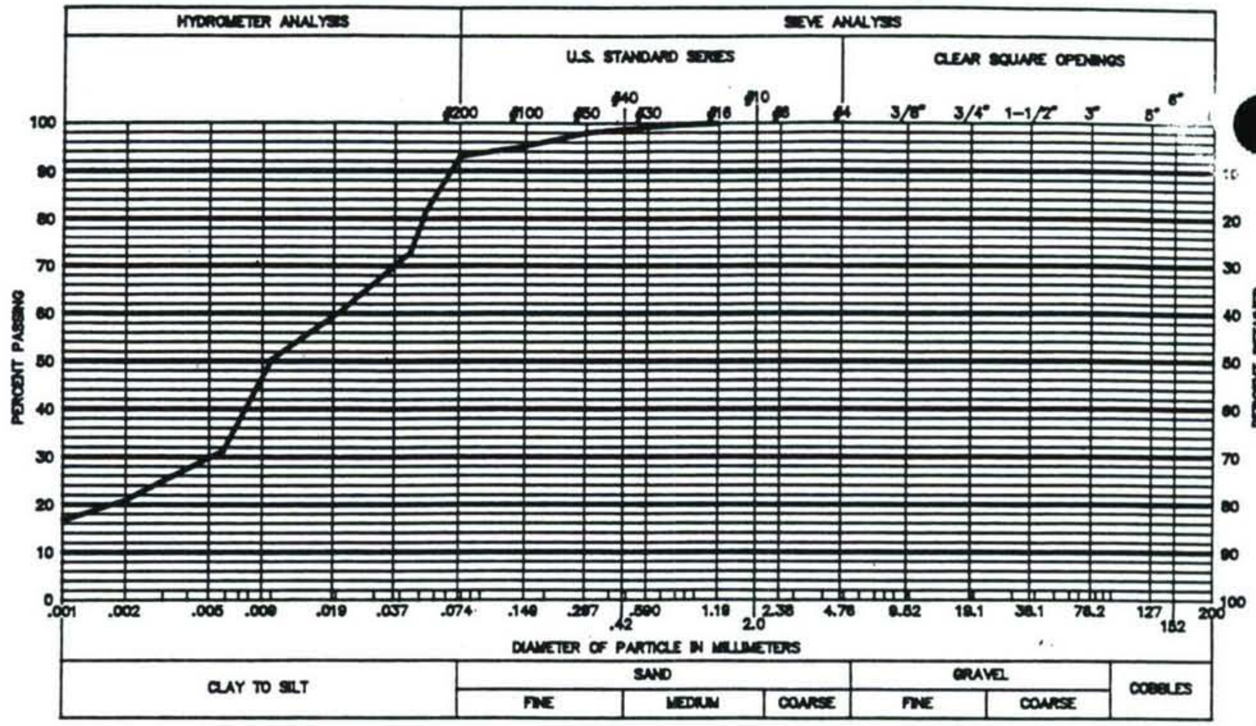
SAMPLE OF SANDY CLAY FROM 01-TA-30-1or2 @ 0'



GRAVEL 0 % SAND 82 % SILT AND CLAY 18 %
LIQUID LIMIT NV PLASTICITY INDEX NP

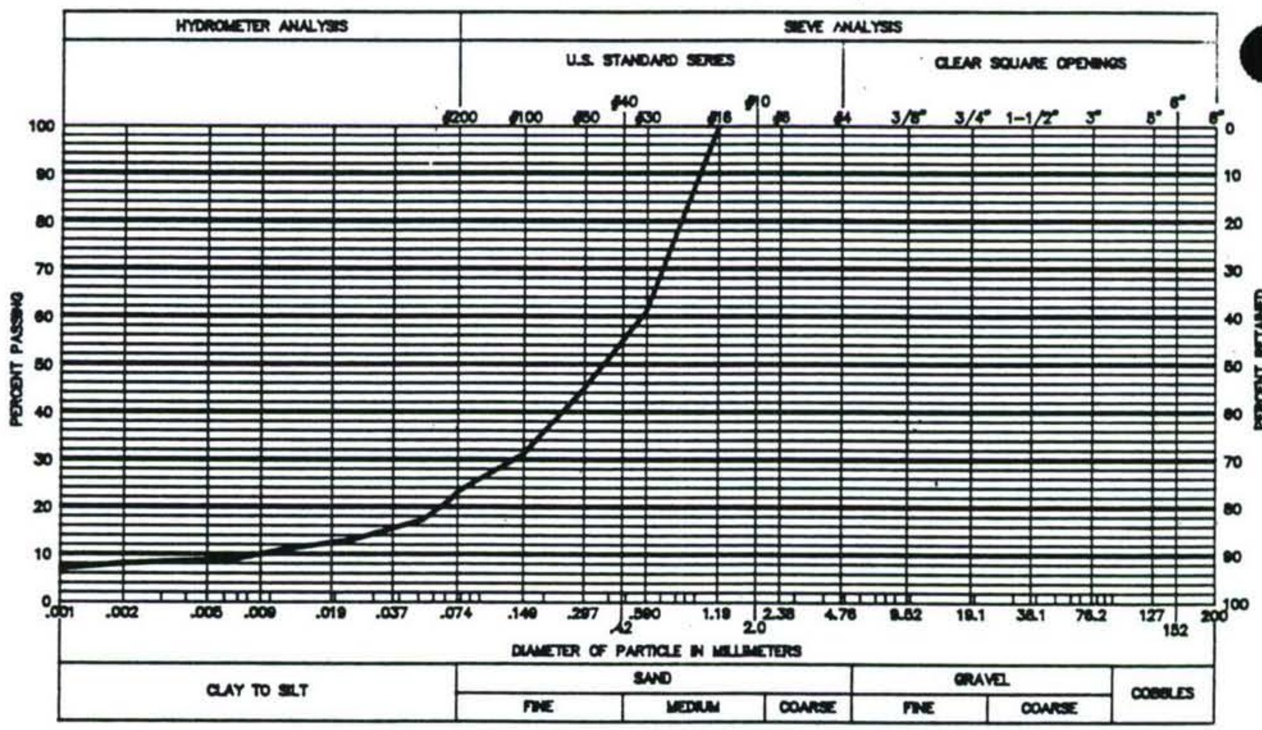
SAMPLE OF SILTY SAND FROM 25-AM-58 @ 0'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 1



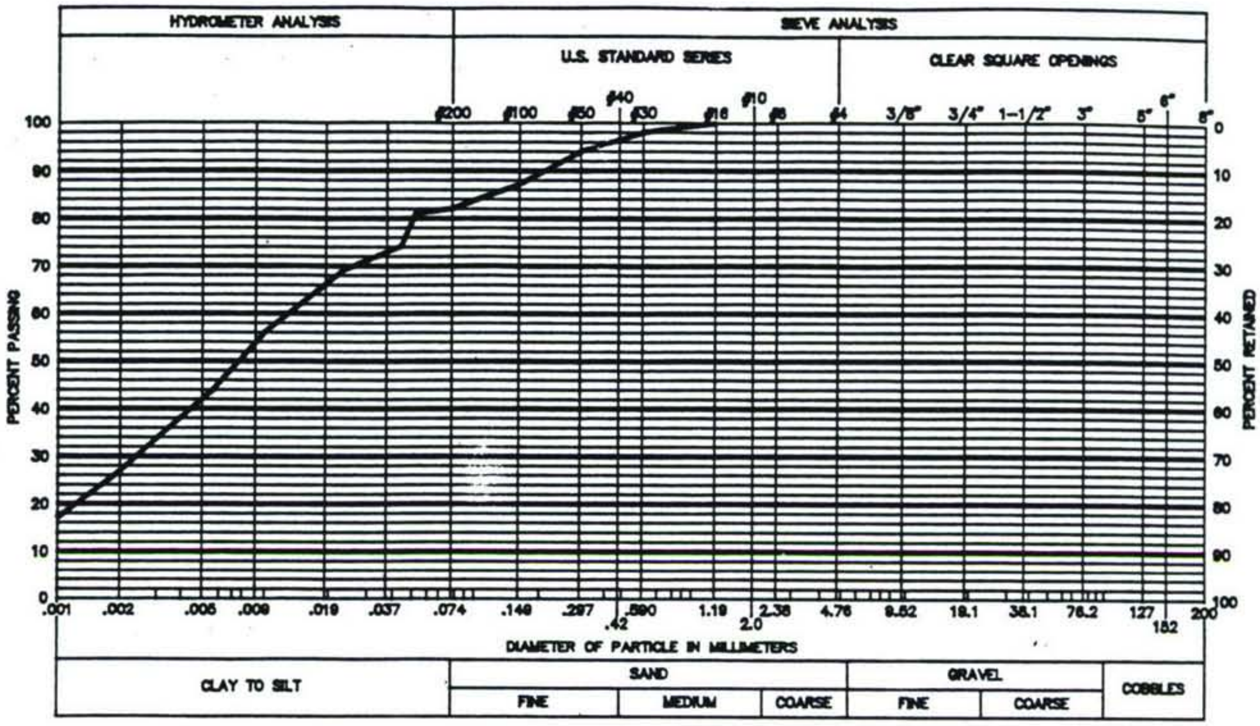
GRAVEL 0 % SAND 7 % SILT AND CLAY 93 %
LIQUID LIMIT 43 PLASTICITY INDEX 15

SAMPLE OF SLIGHTLY SANDY SILT FROM 01-HBA-84 ● 0'



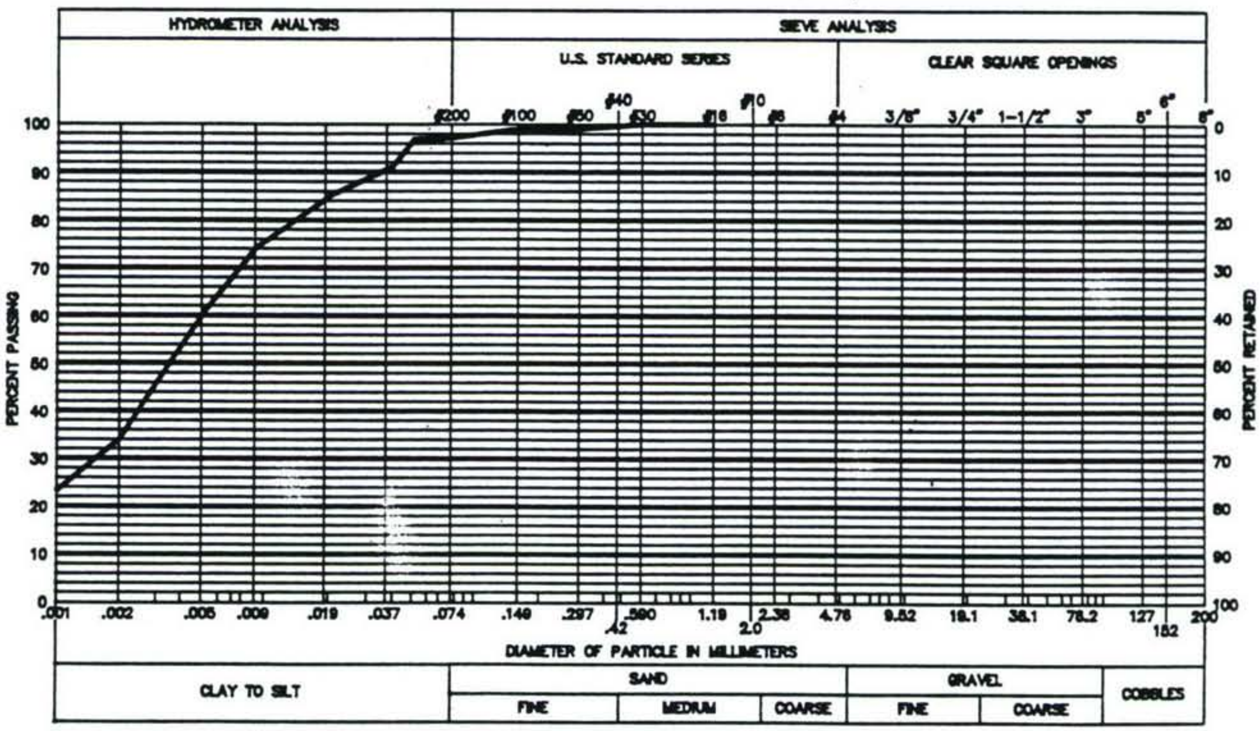
GRAVEL 0 % SAND 76 % SILT AND CLAY 24 %
LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF SILTY SAND FROM 25-WIND ● 0'



GRAVEL 0 % SAND 17 % SILT AND CLAY 83 %
LIQUID LIMIT 43 PLASTICITY INDEX 17

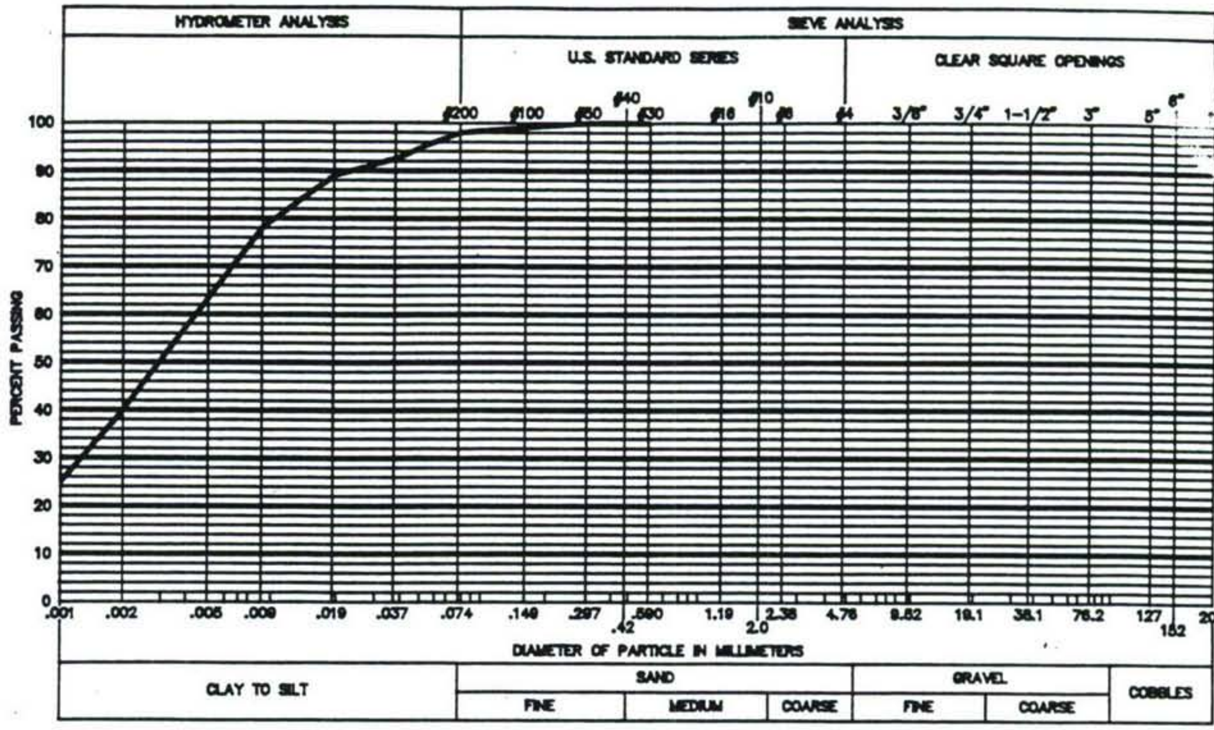
SAMPLE OF SANDY CLAY FROM 25-AM-58 @ 4-5'



GRAVEL 0 % SAND 2 % SILT AND CLAY 98 %
LIQUID LIMIT 30 PLASTICITY INDEX 11

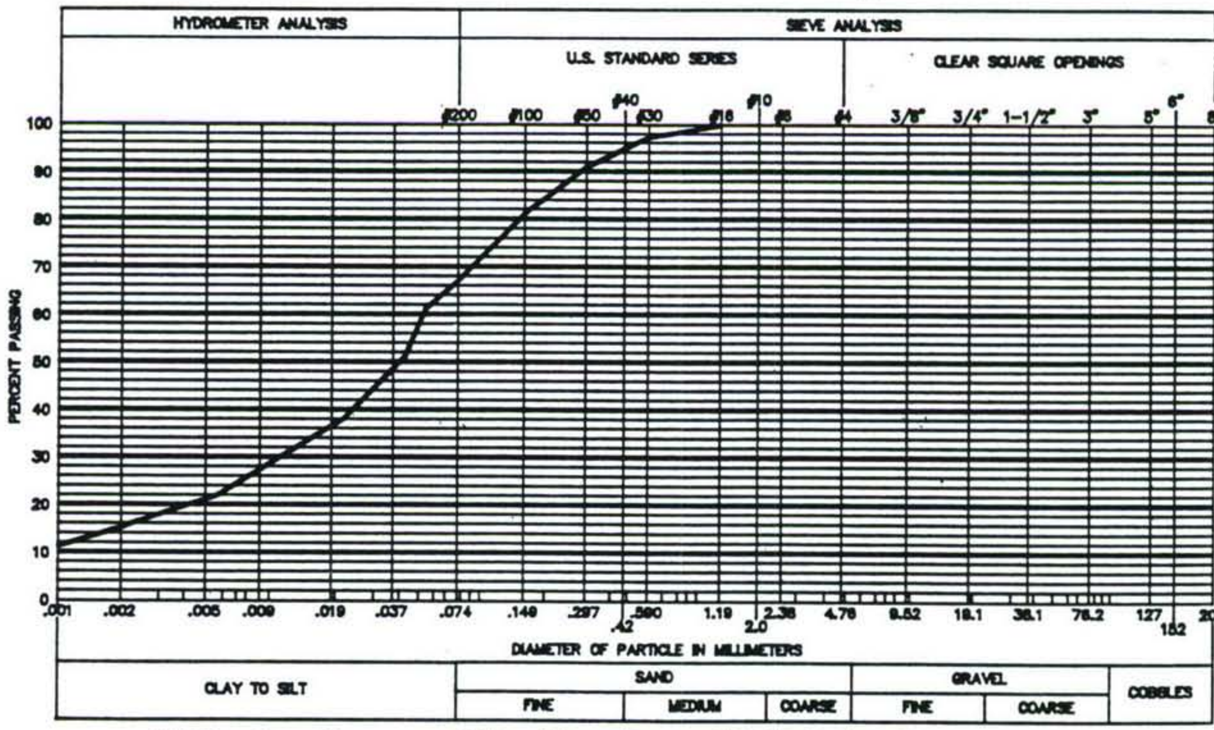
SAMPLE OF SILTY CLAY FROM 25-CT-07 @ 0'

1 473 93	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 3



GRAVEL 0 % SAND 1 % SILT AND CLAY 99 %
LIQUID LIMIT 37 PLASTICITY INDEX 17

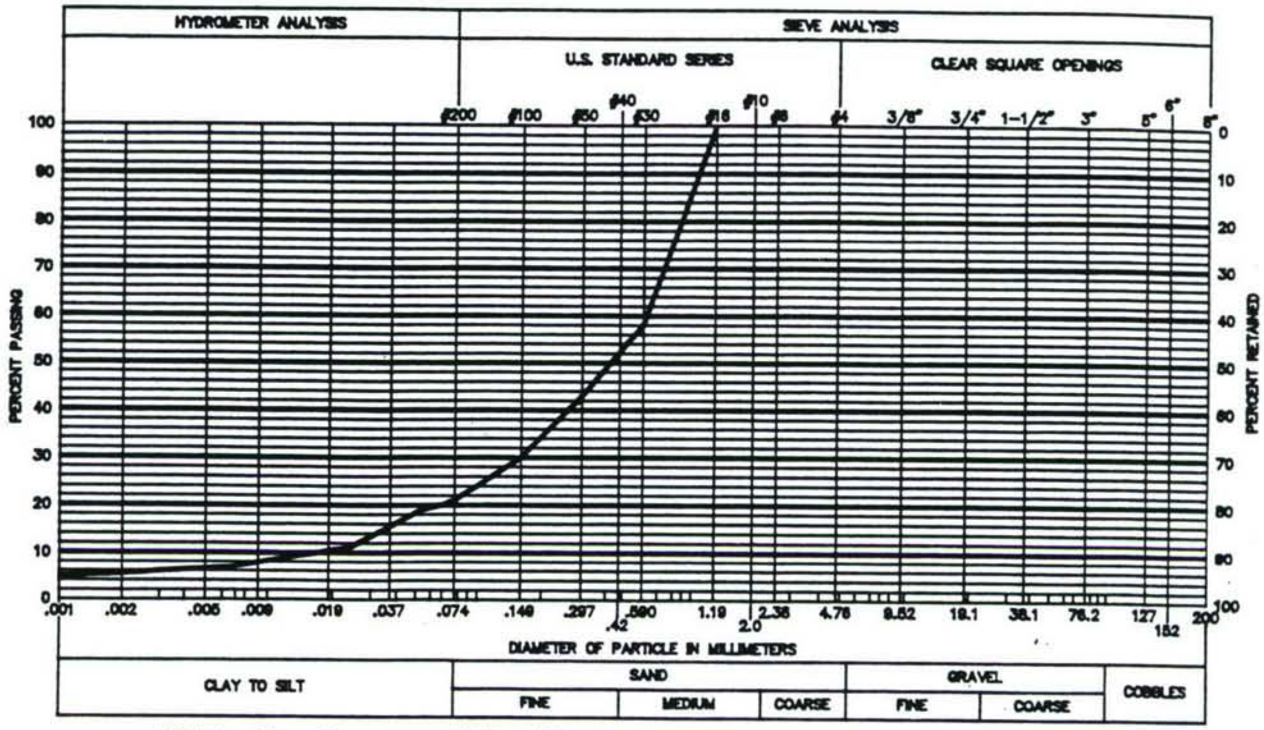
SAMPLE OF SILTY CLAY FROM 25-WIND @ 4-5'



GRAVEL 0 % SAND 33 % SILT AND CLAY 67 %
LIQUID LIMIT NV PLASTICITY INDEX NP

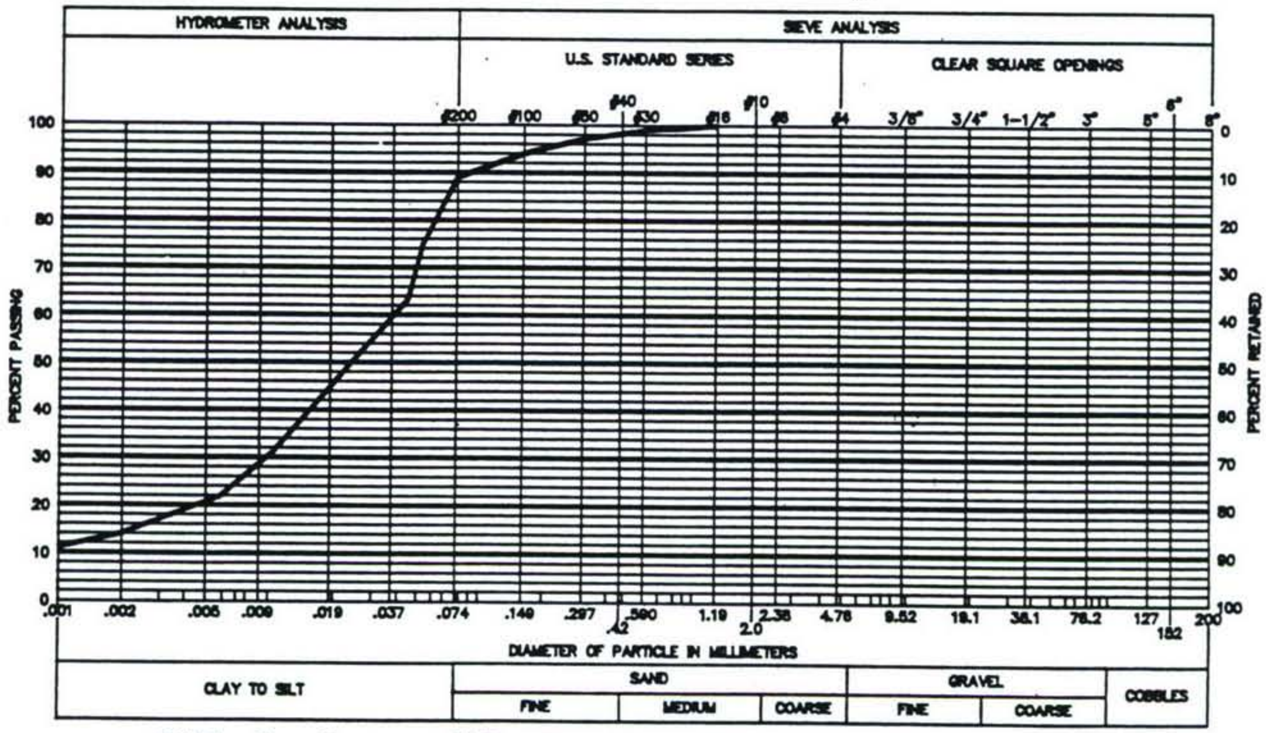
SAMPLE OF SLIGHTLY CLAYEY SANDY SILT FROM 01-MSD-58 @ 0'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 4



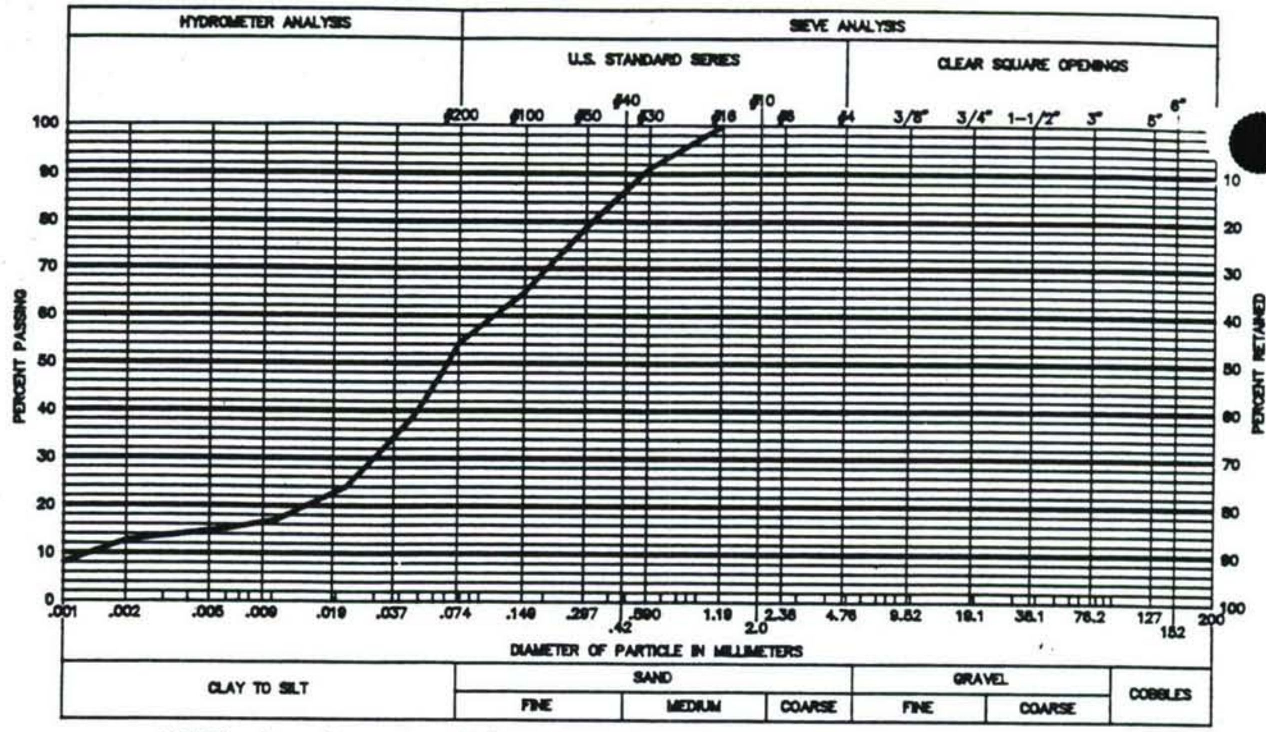
GRAVEL 0 % SAND 78 % SILT AND CLAY 22 %
LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF SILTY SAND FROM 01-IAM-08 @ 0'



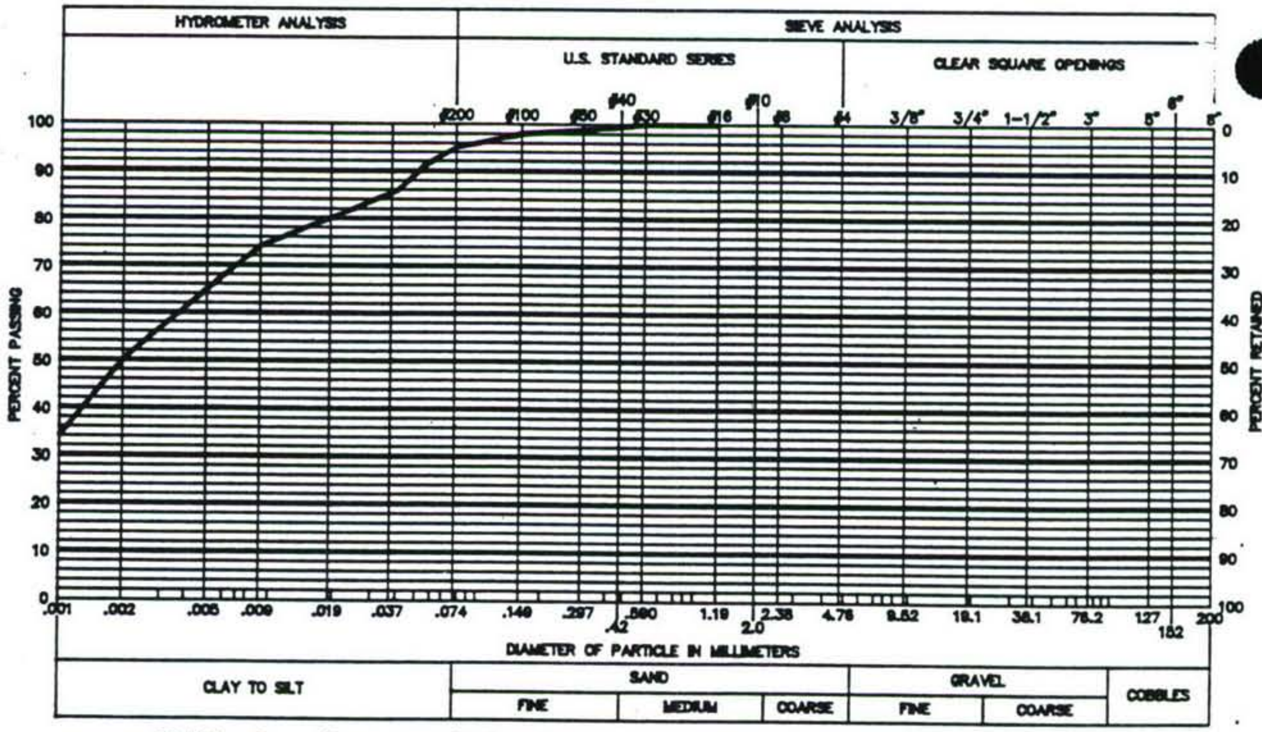
GRAVEL 0 % SAND 11 % SILT AND CLAY 89 %
LIQUID LIMIT 38 PLASTICITY INDEX 9

SAMPLE OF SANDY SILT FROM 01-MP-82 @ 0'



GRAVEL 0 % SAND 46 % SILT AND CLAY 54 %
LIQUID LIMIT NV PLASTICITY INDEX NP

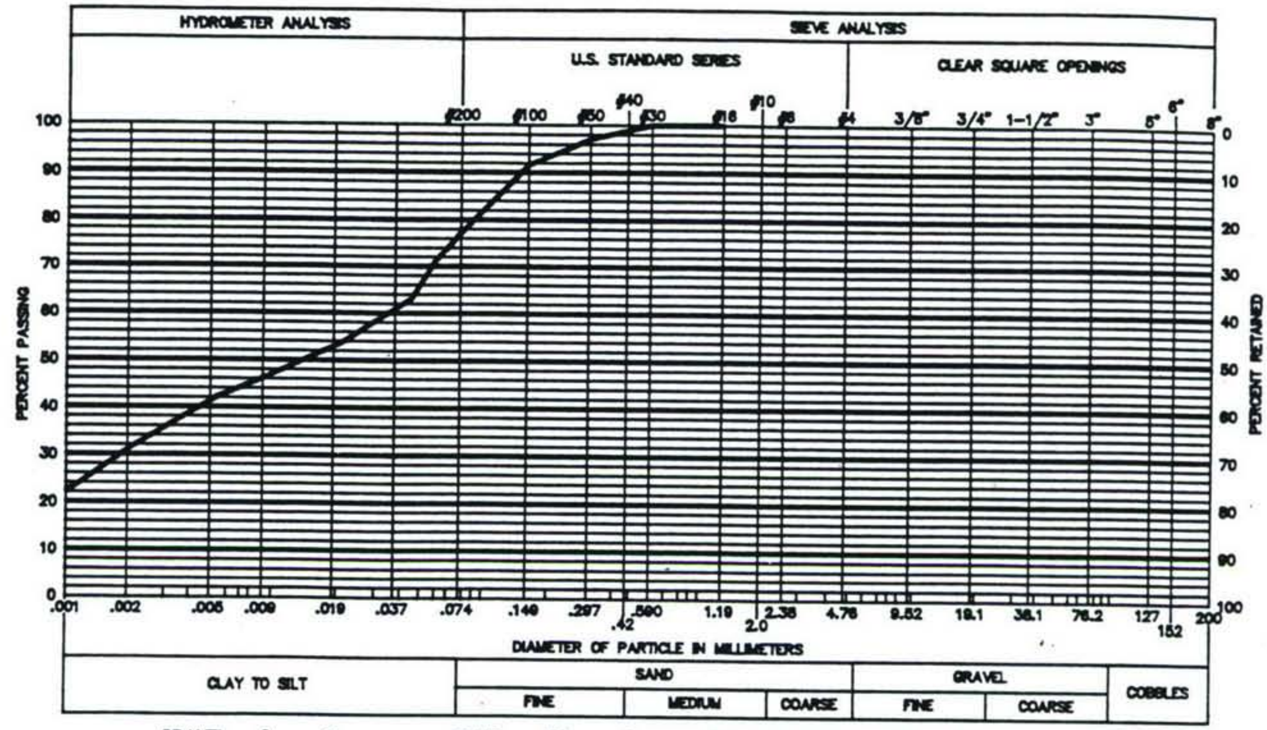
SAMPLE OF VERY SANDY SILT FROM 01-PCA-88 @ 0'



GRAVEL 0 % SAND 5 % SILT AND CLAY 95 %
LIQUID LIMIT 37 PLASTICITY INDEX 18

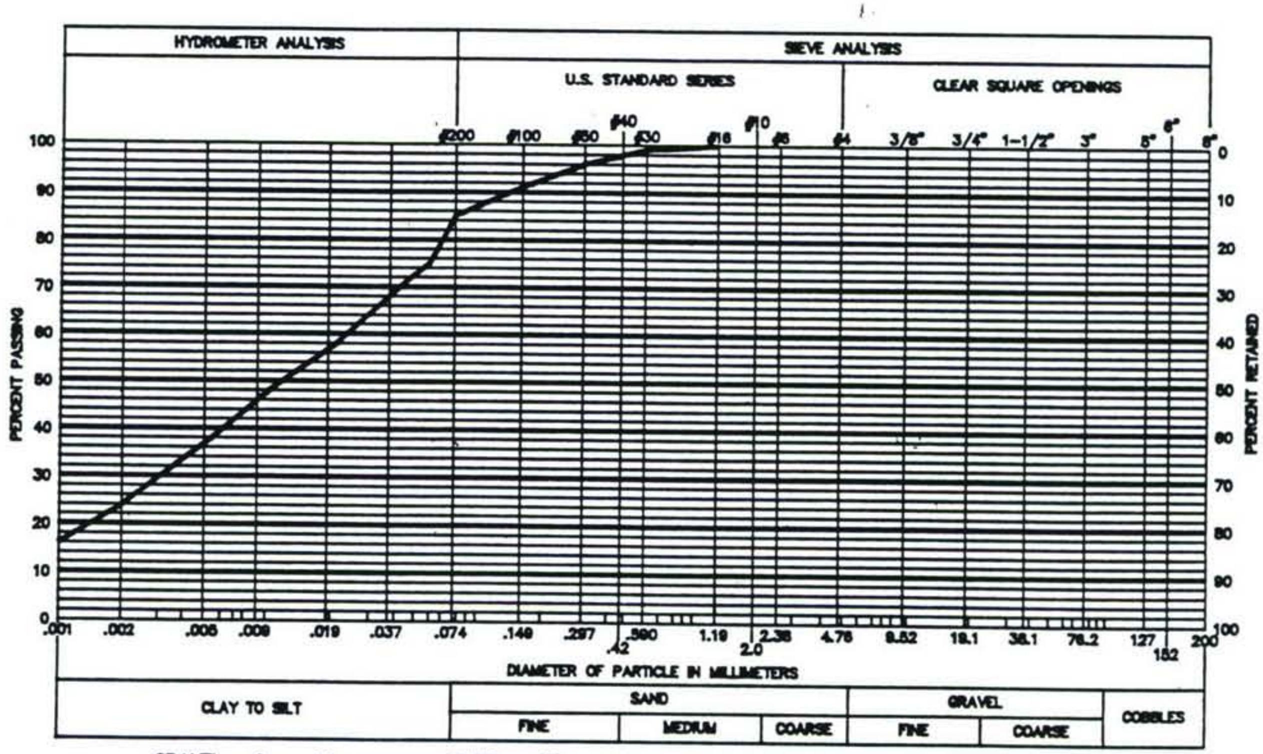
SAMPLE OF SLIGHTLY SANDY CLAY FROM 25-IDC-10 @ 0'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 6



GRAVEL 0 % SAND 22 % SILT AND CLAY 78 %
LIQUID LIMIT 25 PLASTICITY INDEX 7

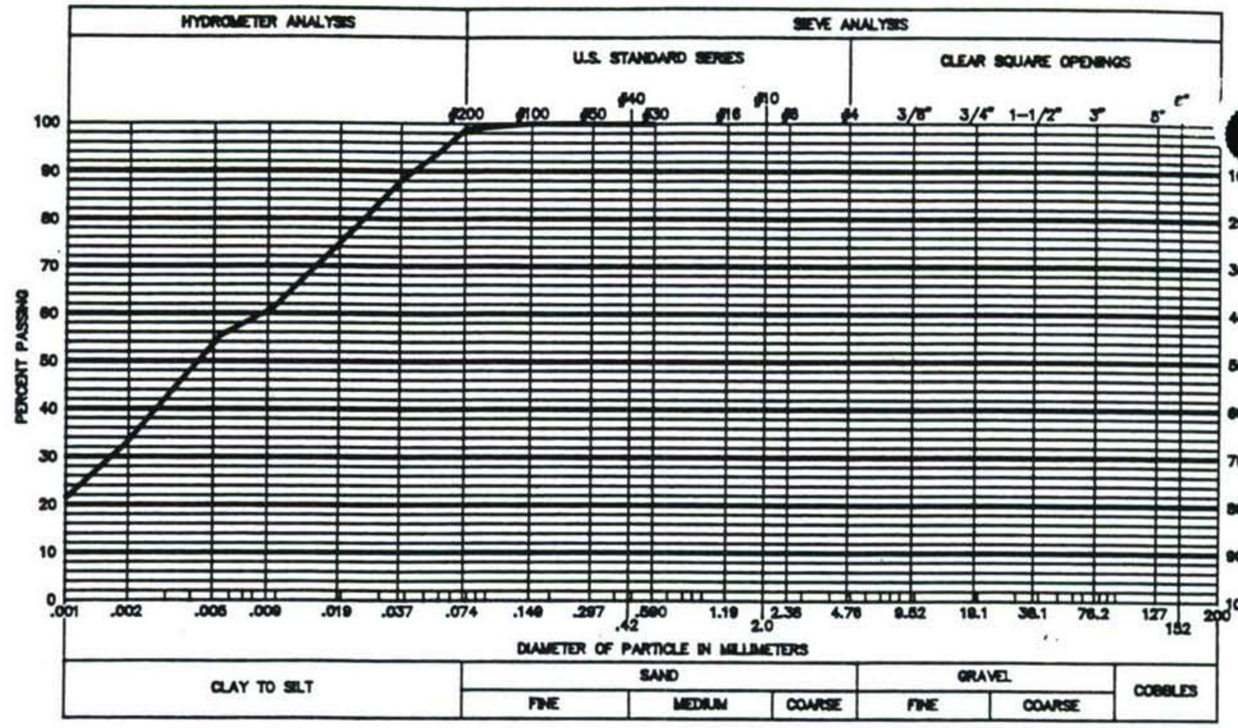
SAMPLE OF VERY SANDY CLAY FROM 25-ODC-108 @ 0-2"



GRAVEL 0 % SAND 15 % SILT AND CLAY 85 %
LIQUID LIMIT 41 PLASTICITY INDEX 14

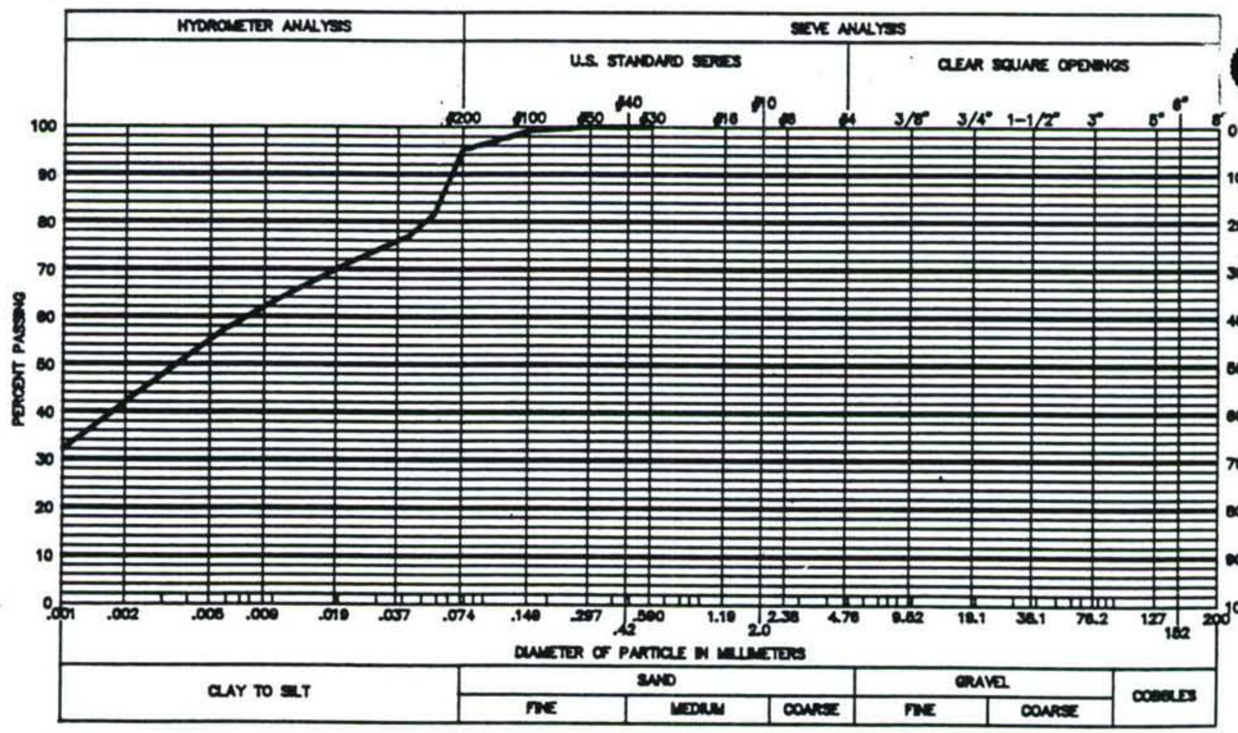
SAMPLE OF SANDY SILT FROM 01-CP-44 @ 0'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 7



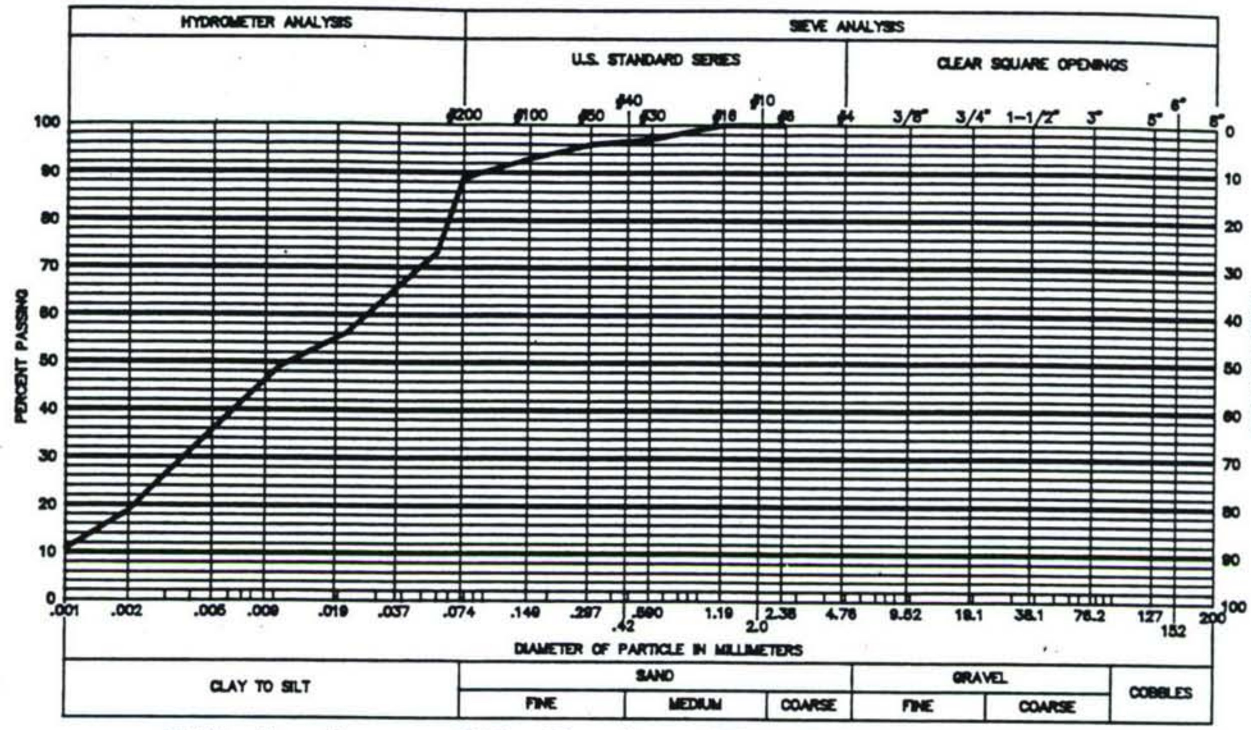
GRAVEL 0 % SAND 1 % SILT AND CLAY 99 %
LIQUID LIMIT 71 PLASTICITY INDEX 41

SAMPLE OF HIGHLY PLASTIC CLAY FROM S-98-92 ● 39-41'



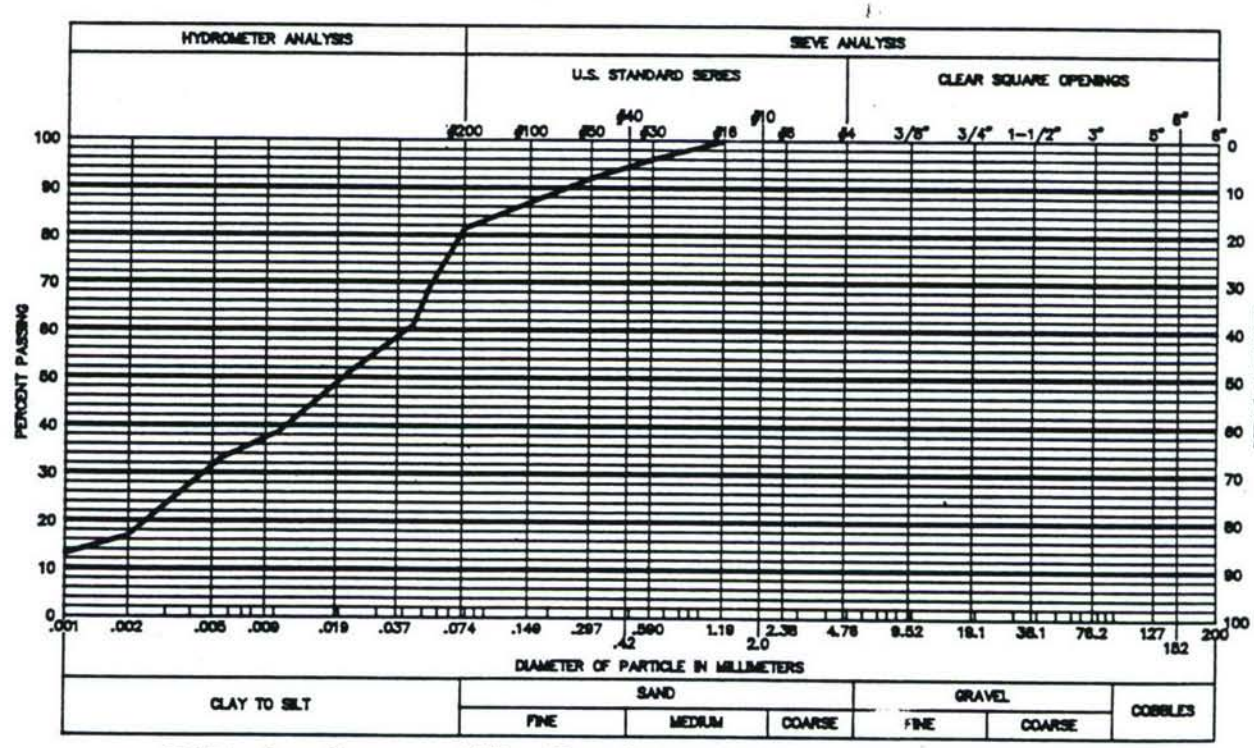
GRAVEL 0 % SAND 4 % SILT AND CLAY 96 %
LIQUID LIMIT 57 PLASTICITY INDEX 33

SAMPLE OF SLIGHTLY SANDY, HIGHLY PLASTIC CLAY FROM S-98-92 ● 34-36'



GRAVEL 0 % SAND 10 % SILT AND CLAY 90 %
LIQUID LIMIT 43 PLASTICITY INDEX 19

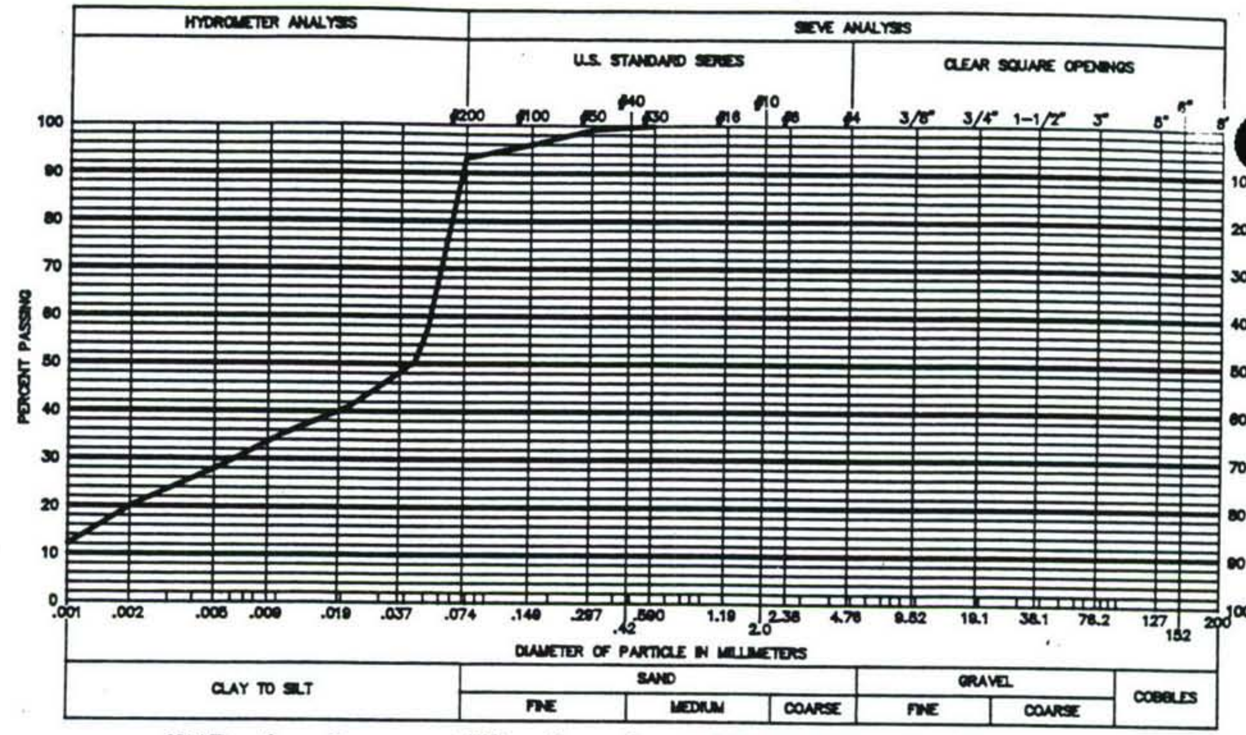
SAMPLE OF SANDY CLAY FROM S-97-92 @ 74-76'



GRAVEL 0 % SAND 18 % SILT AND CLAY 82 %
LIQUID LIMIT 46 PLASTICITY INDEX 24

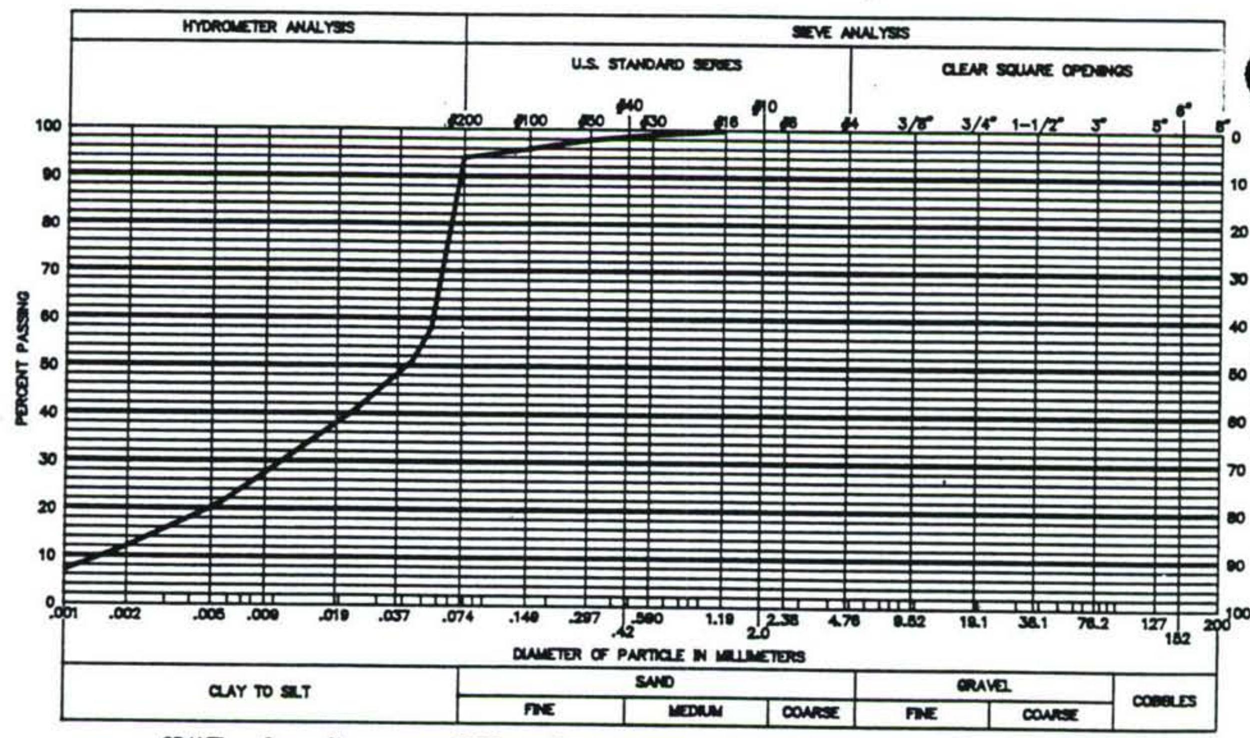
SAMPLE OF SANDY CLAY FROM S-97-92 @ 78-81'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 9



GRAVEL 0 % SAND 7 % SILT AND CLAY 93 %
LIQUID LIMIT 46 PLASTICITY INDEX 16

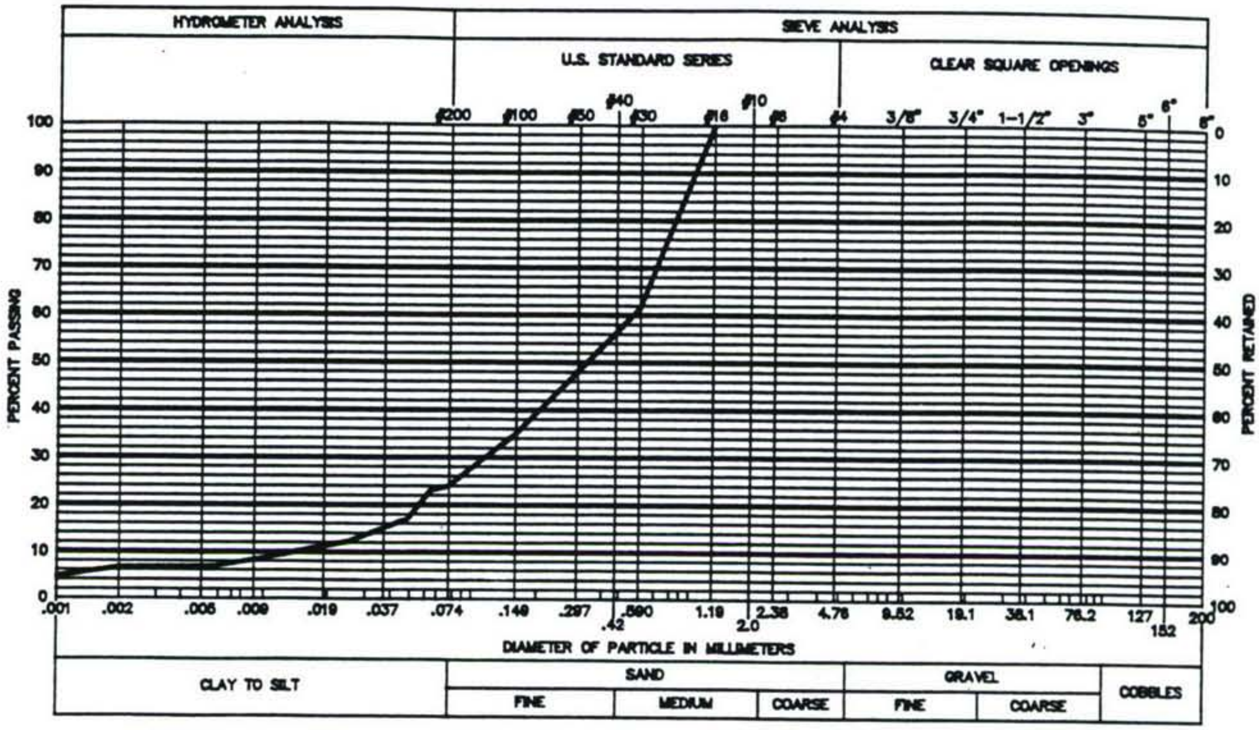
SAMPLE OF SLIGHTLY SANDY SILT FROM S-102-92 @ 39-41'



GRAVEL 0 % SAND 6 % SILT AND CLAY 94 %
LIQUID LIMIT 44 PLASTICITY INDEX 11

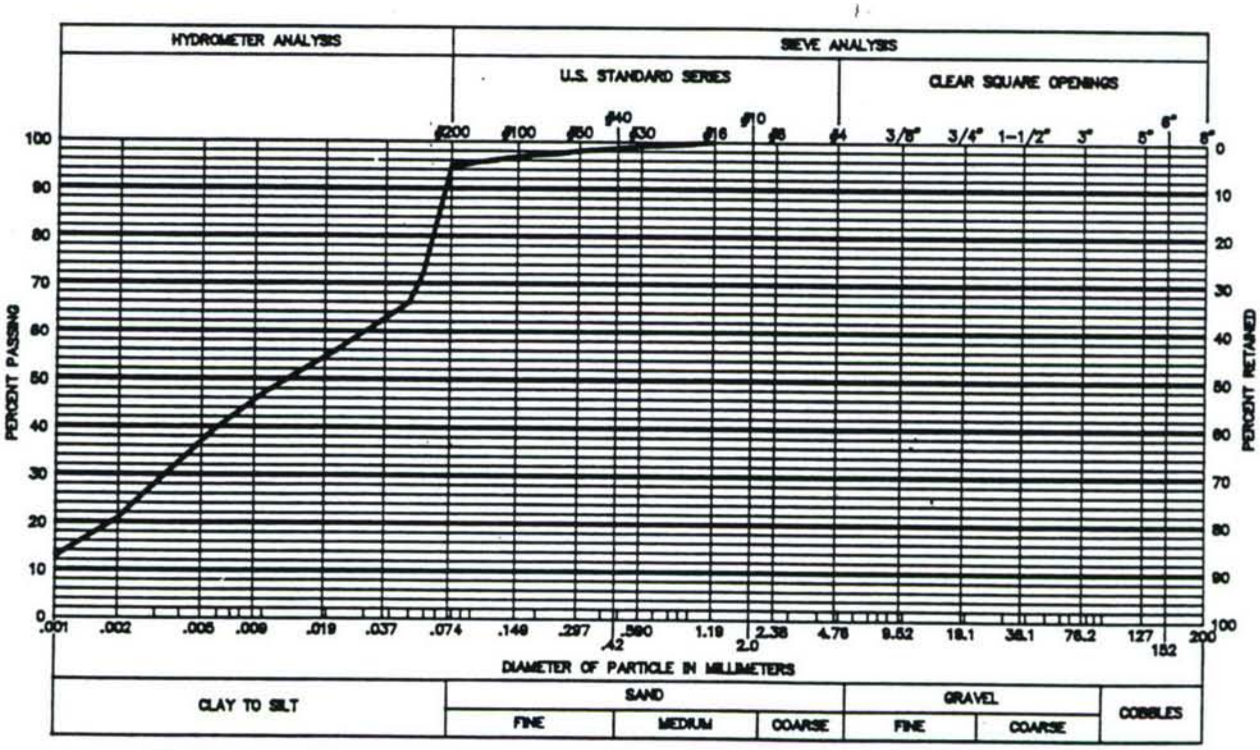
SAMPLE OF SLIGHTLY SANDY SILT FROM S-102-92 @ 44-46'

1 473 93	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 10



GRAVEL 0 % SAND 75 % SILT AND CLAY 25 %
LIQUID LIMIT NV PLASTICITY INDEX NP

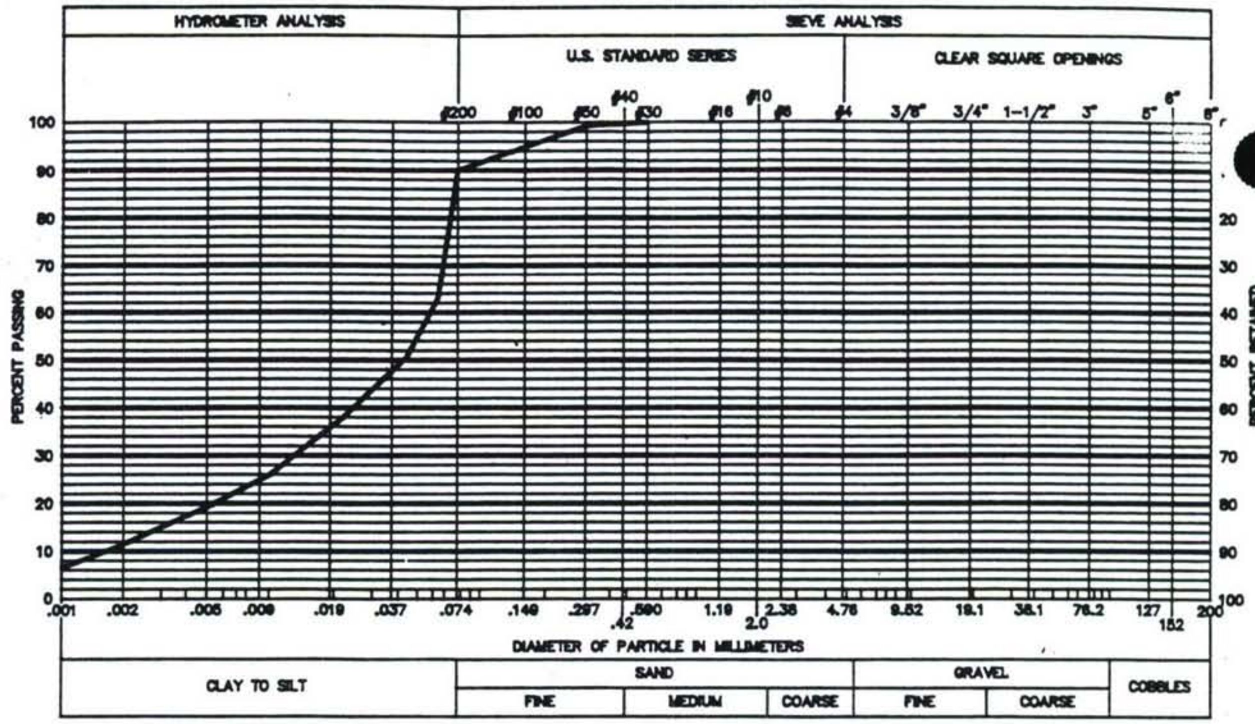
SAMPLE OF SILTY SAND FROM 25-IBA-60 @ 0'



GRAVEL 0 % SAND 5 % SILT AND CLAY 95 %
LIQUID LIMIT 38 PLASTICITY INDEX 18

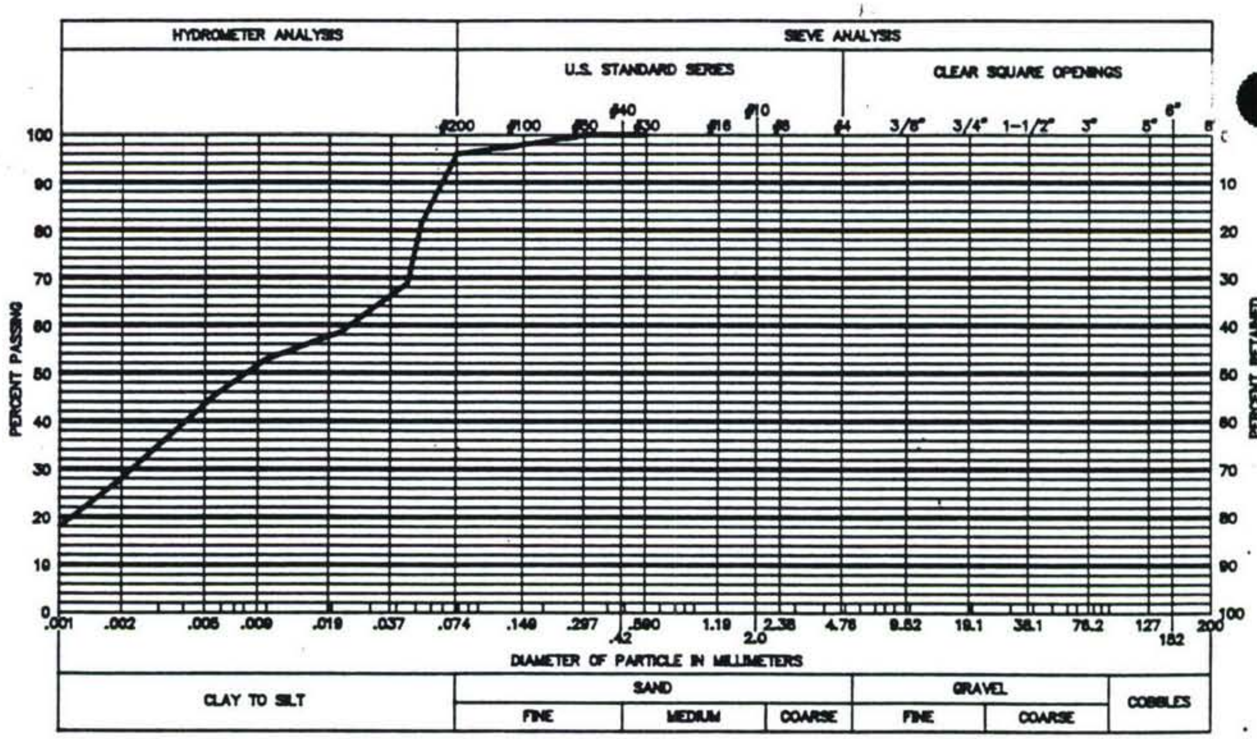
SAMPLE OF SLIGHTLY SANDY CLAY FROM 25-WIND @ 9-10'

1 473 93	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 11



GRAVEL 0 % SAND 10 % SILT AND CLAY 90 %
LIQUID LIMIT 60 PLASTICITY INDEX 18

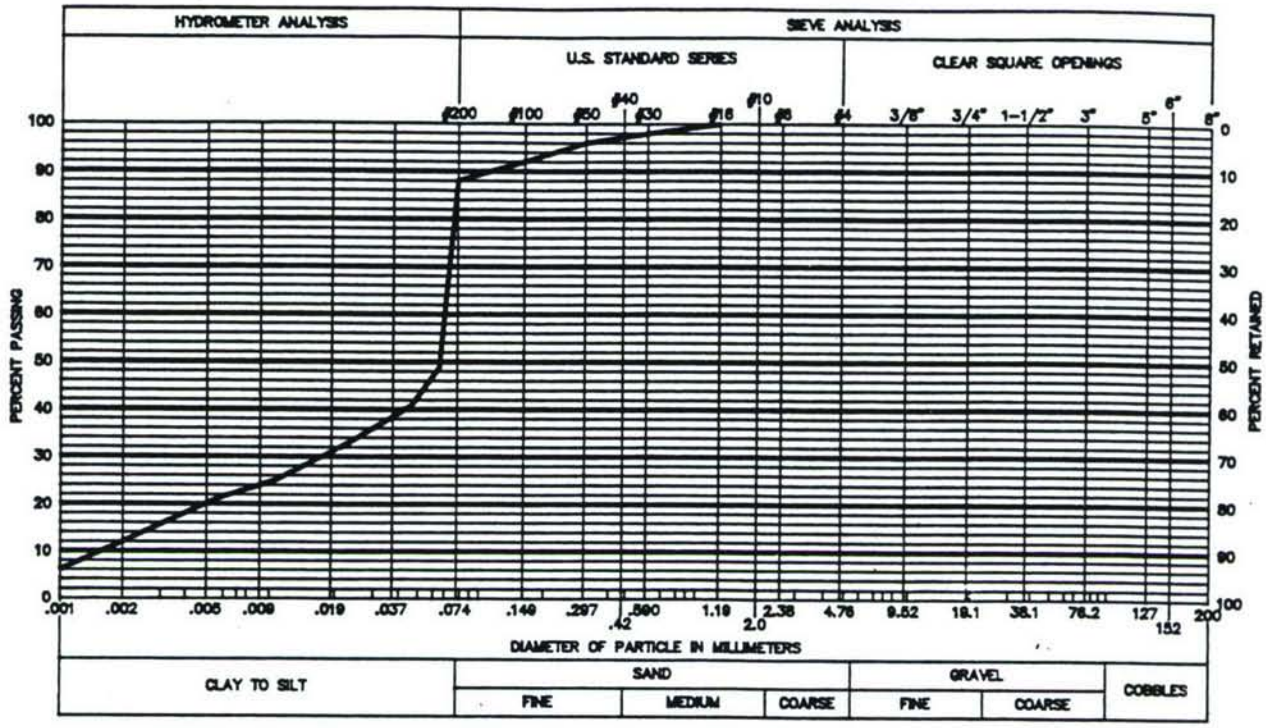
SAMPLE OF SLIGHTLY SANDY SILT FROM S-100-92 ● 67-71'



GRAVEL 0 % SAND 3 % SILT AND CLAY 97 %
LIQUID LIMIT 71 PLASTICITY INDEX 40

SAMPLE OF SLIGHTLY SANDY, HIGHLY PLASTIC CLAY FROM S-100-92 ● 72-74'

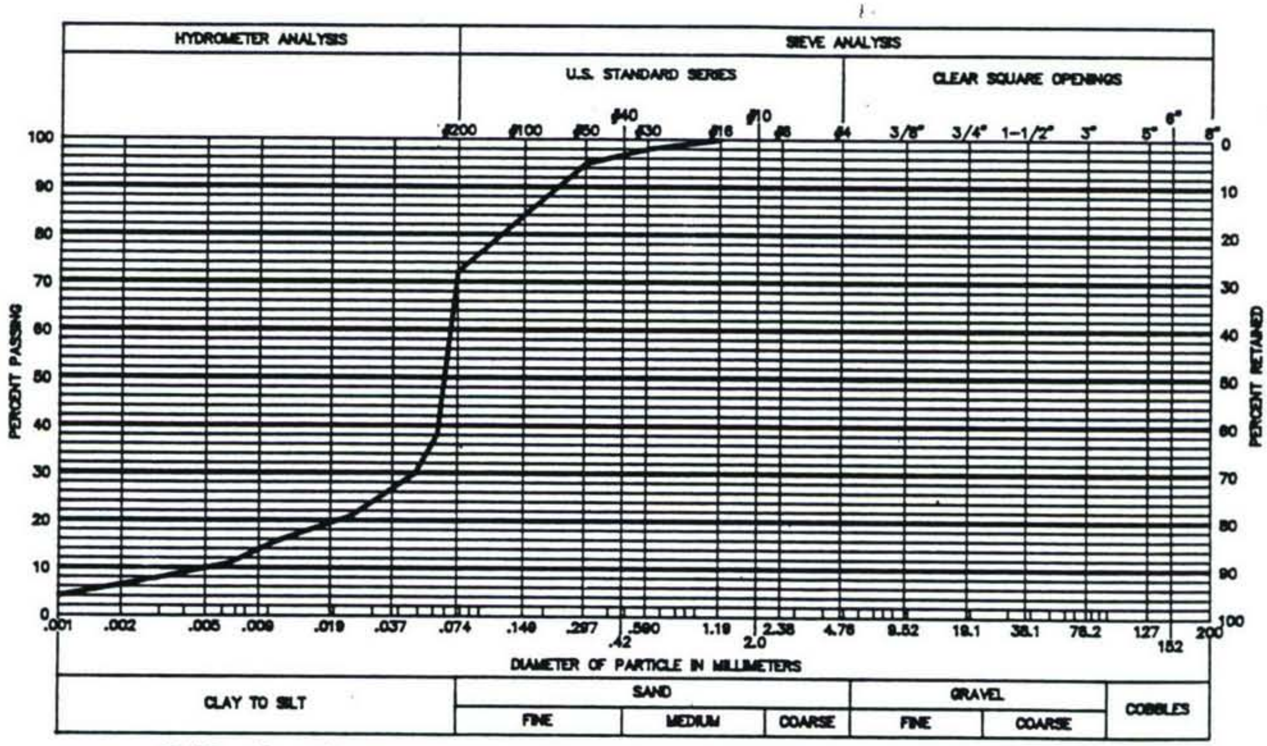
1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 12



GRAVEL 0 % SAND 11 % SILT AND CLAY 89 %

LIQUID LIMIT 42 PLASTICITY INDEX 16

SAMPLE OF SANDY SILT FROM S-102-92 @ 29-31'

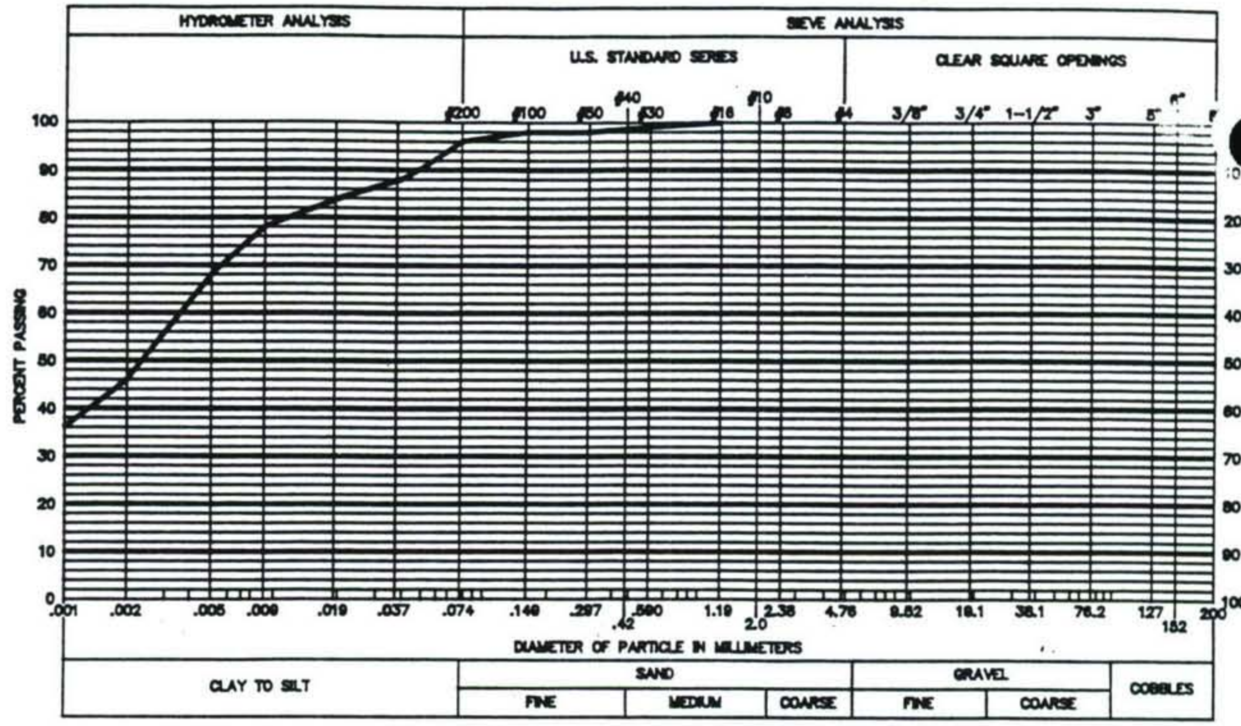


GRAVEL 0 % SAND 28 % SILT AND CLAY 72 %

LIQUID LIMIT 36 PLASTICITY INDEX 8

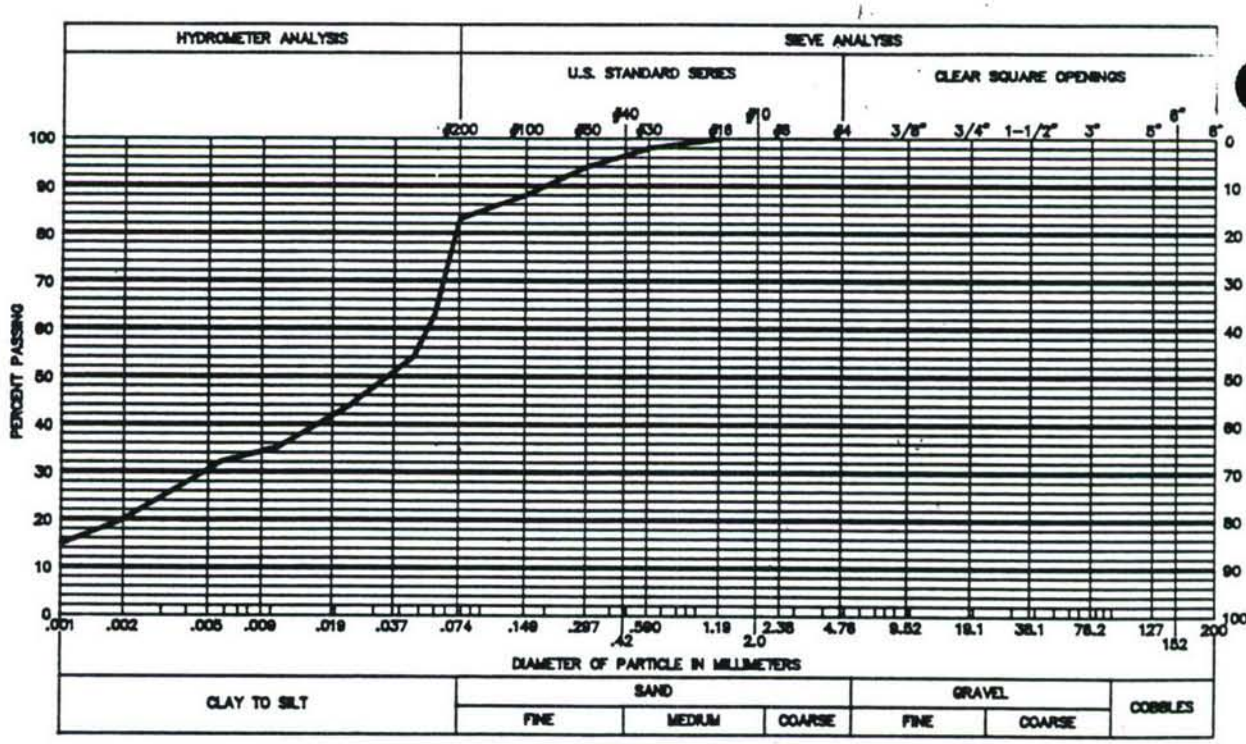
SAMPLE OF VERY SANDY SILT FROM S-102-92 @ 34-36'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 13



GRAVEL 0 % SAND 4 % SILT AND CLAY 96 %
LIQUID LIMIT 40 PLASTICITY INDEX 22

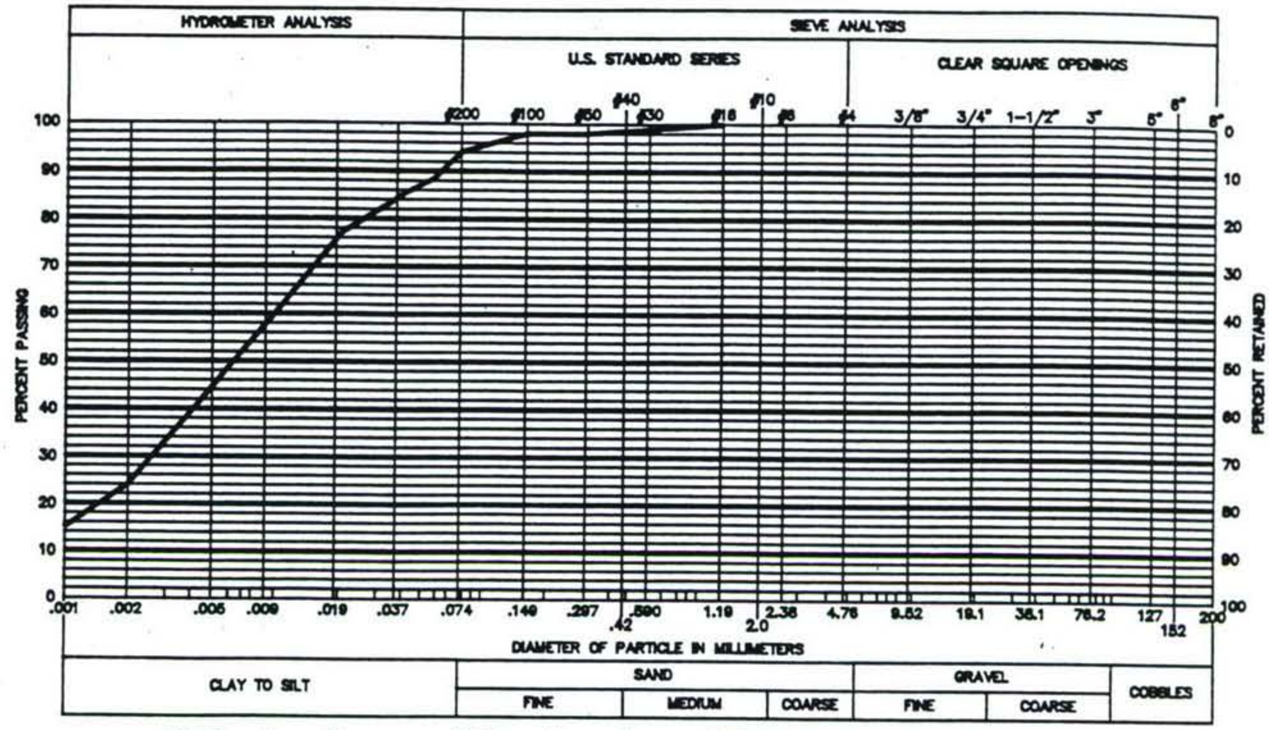
SAMPLE OF SILTY CLAY FROM S-101-92 ● 44-46'



GRAVEL 0 % SAND 17 % SILT AND CLAY 83 %
LIQUID LIMIT 37 PLASTICITY INDEX 14

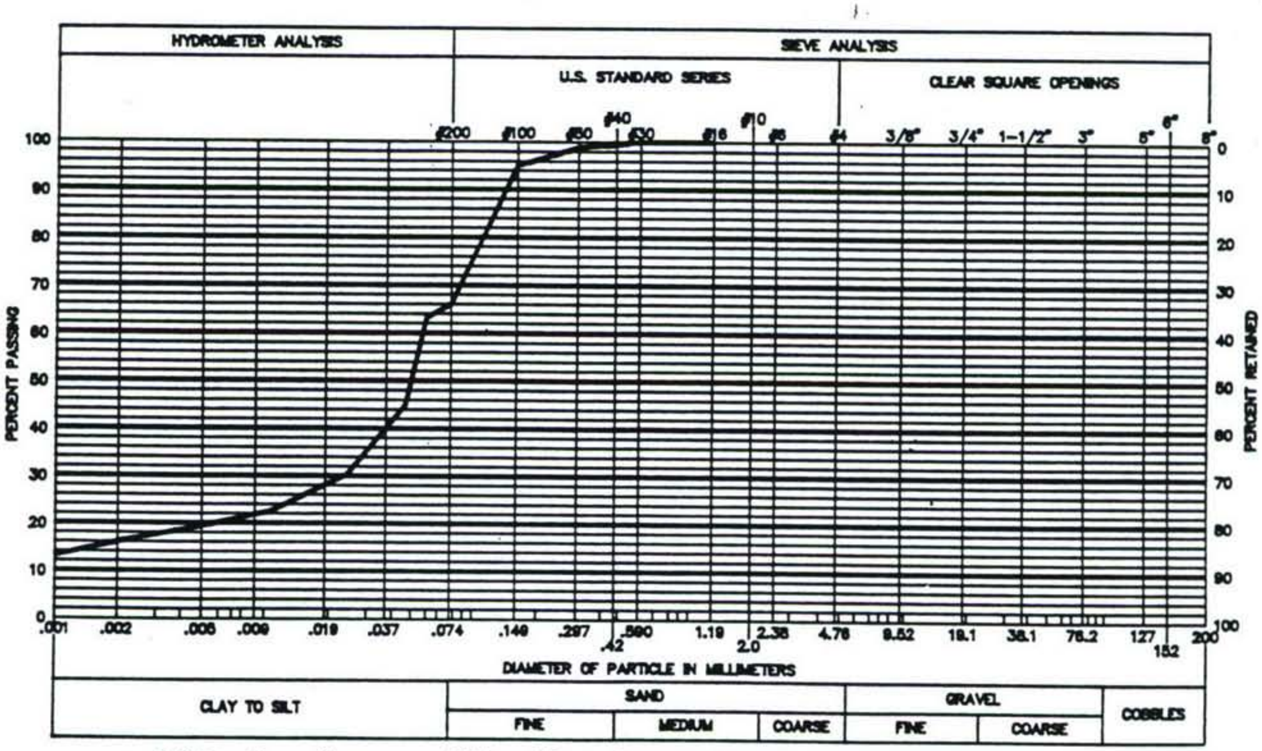
SAMPLE OF SANDY CLAY FROM S-101-92 ● 49-50'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 14



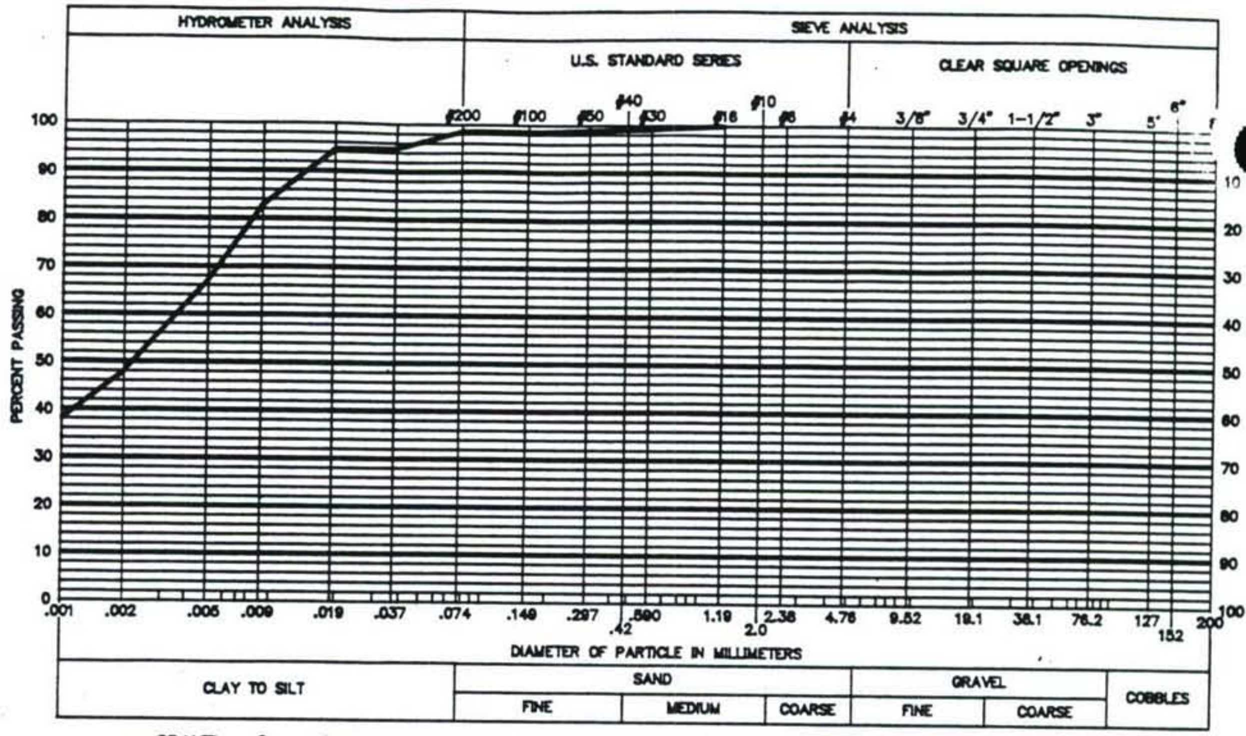
GRAVEL 0 % SAND 5 % SILT AND CLAY 95 %
LIQUID LIMIT 33 PLASTICITY INDEX 13

SAMPLE OF SLIGHTLY SANDY, SILTY CLAY FROM 25-AM-58 @ 9-10'



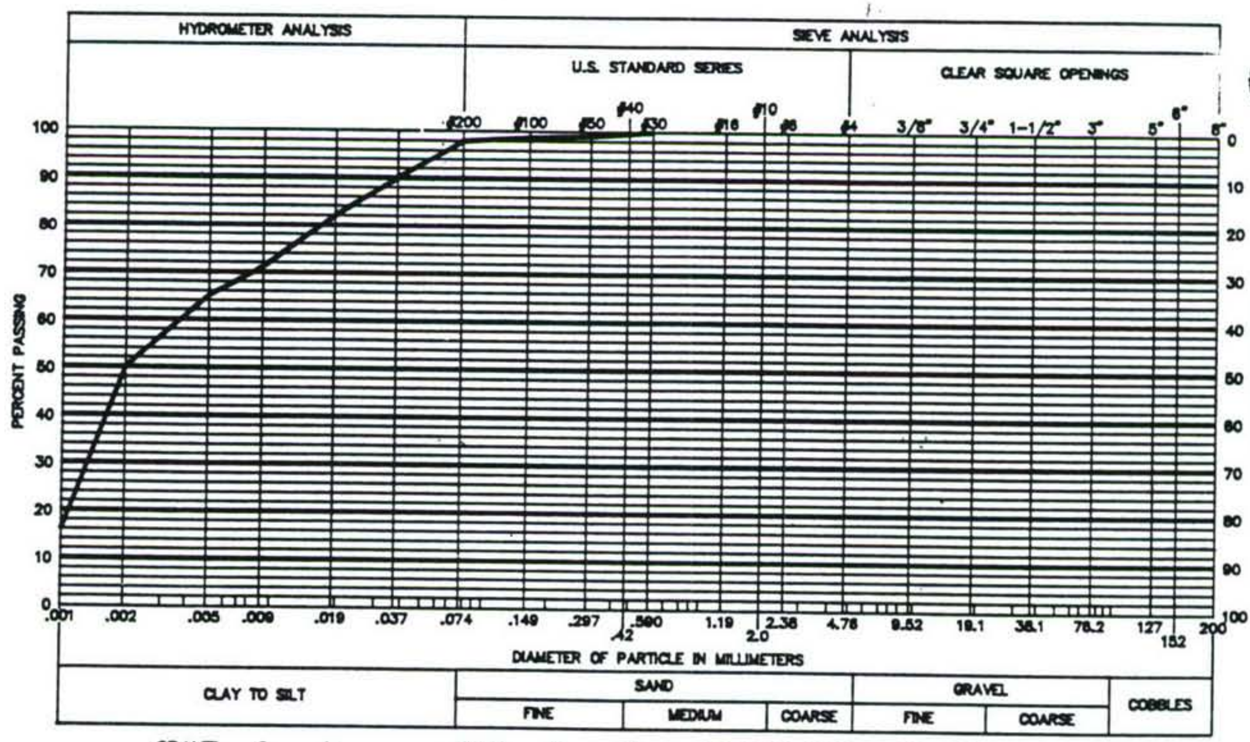
GRAVEL 0 % SAND 35 % SILT AND CLAY 65 %
LIQUID LIMIT 54 PLASTICITY INDEX 29

SAMPLE OF VERY SANDY CLAY FROM TEST HOLE (S-93-92) @ 144-145'



GRAVEL 0 % SAND 1 % SILT AND CLAY 99 %
LIQUID LIMIT 64 PLASTICITY INDEX 42

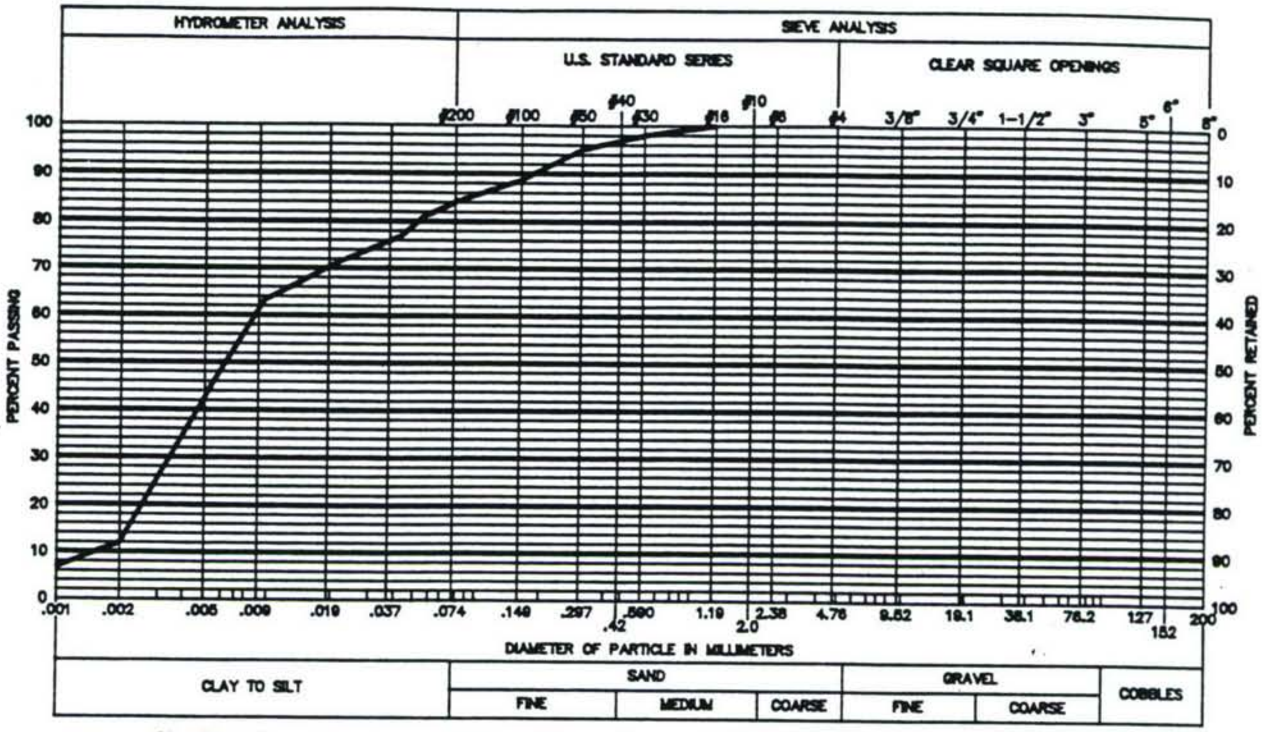
SAMPLE OF SLIGHTLY SILTY CLAY FROM TEST HOLE (S-93-92) @ 148-150'



GRAVEL 0 % SAND 2 % SILT AND CLAY 98 %
LIQUID LIMIT 75 PLASTICITY INDEX 49

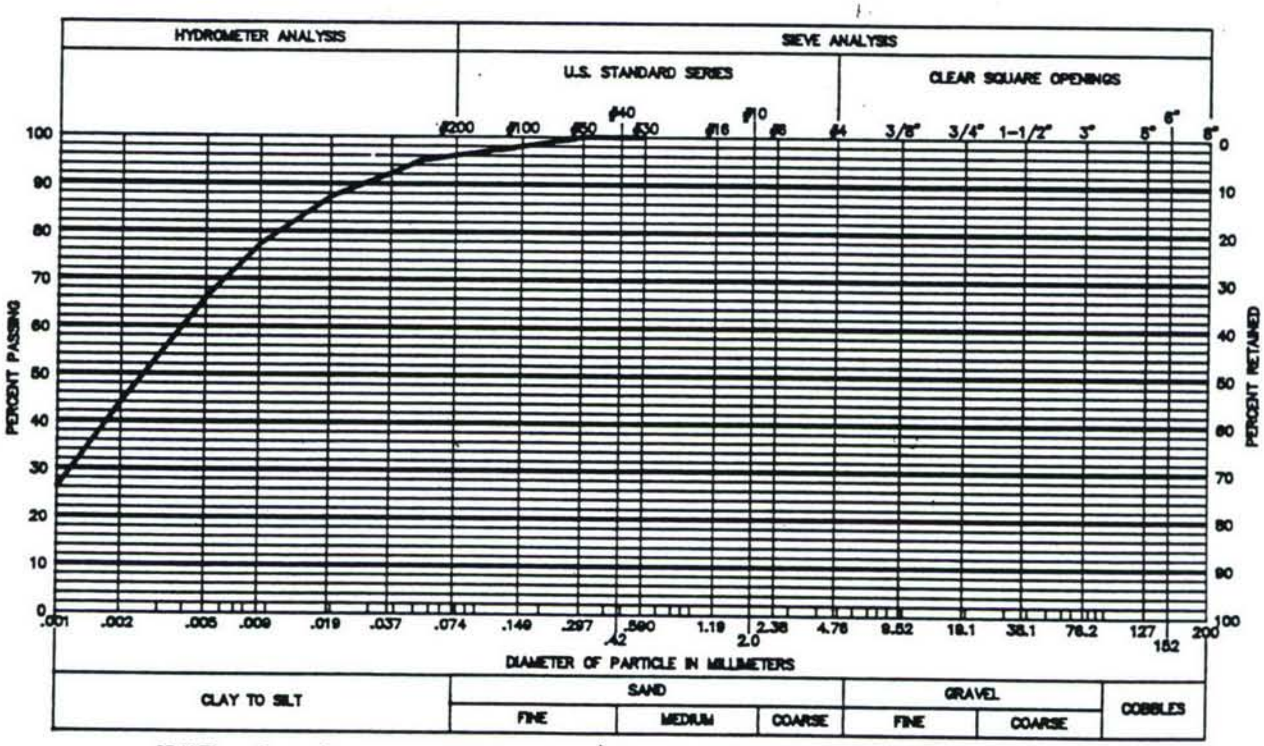
SAMPLE OF SILTY, HIGHLY PLASTIC CLAY FROM S-95-92 @ 109-111'

1 473 93	Chen-Northern, Inc.	GRADATION TEST RESULTS	Fig. 16



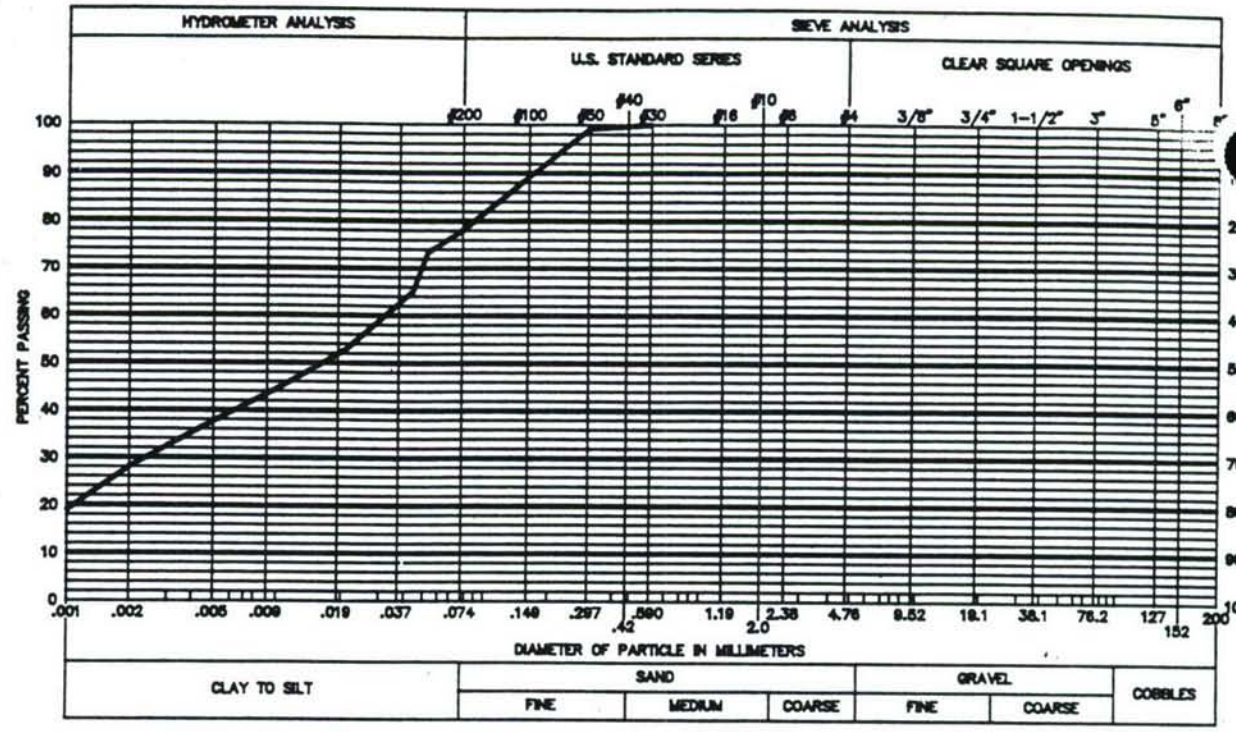
GRAVEL 0 % SAND 15 % SILT AND CLAY 85 %
LIQUID LIMIT 53 PLASTICITY INDEX 28

SAMPLE OF SANDY CLAY FROM S-95-92 @ 129-131'



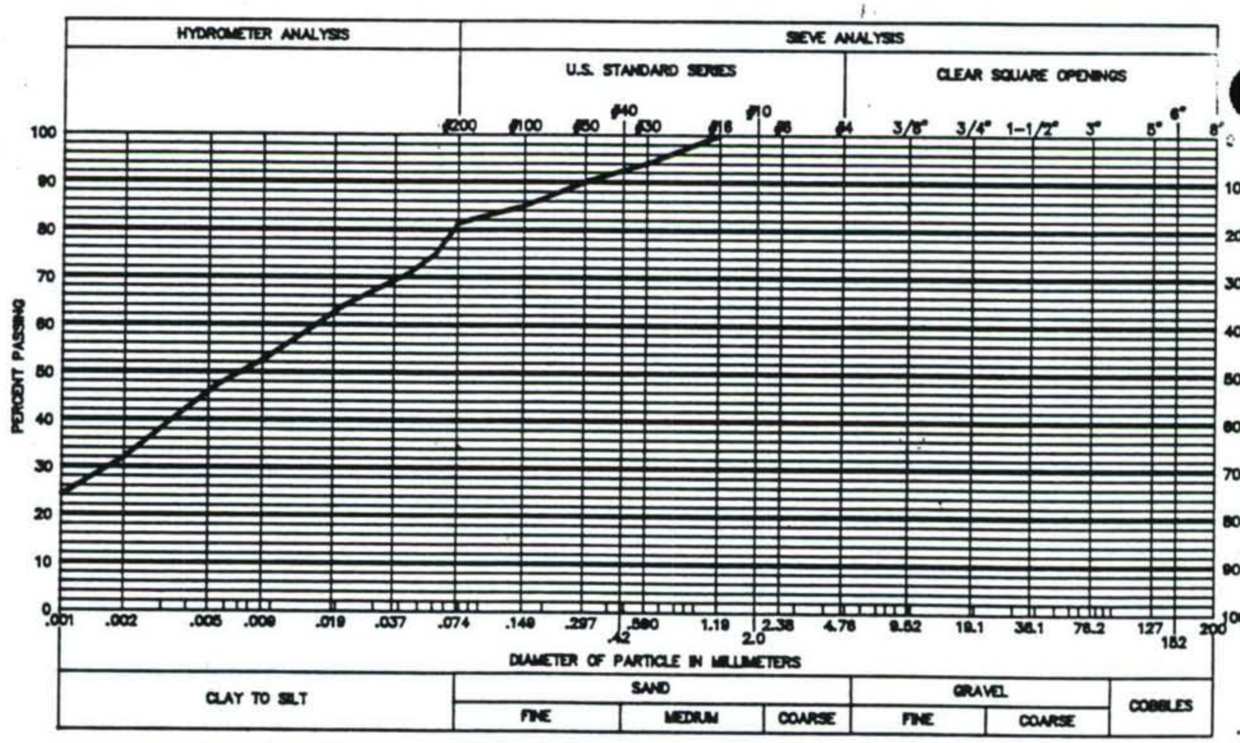
GRAVEL 0 % SAND 4 % SILT AND CLAY 96 %
LIQUID LIMIT 69 PLASTICITY INDEX 45

SAMPLE OF HIGHLY PLASTIC CLAY FROM S-96-92 @ 109-110'



GRAVEL 0 % SAND 22 % SILT AND CLAY 78 %
LIQUID LIMIT 35 PLASTICITY INDEX 17

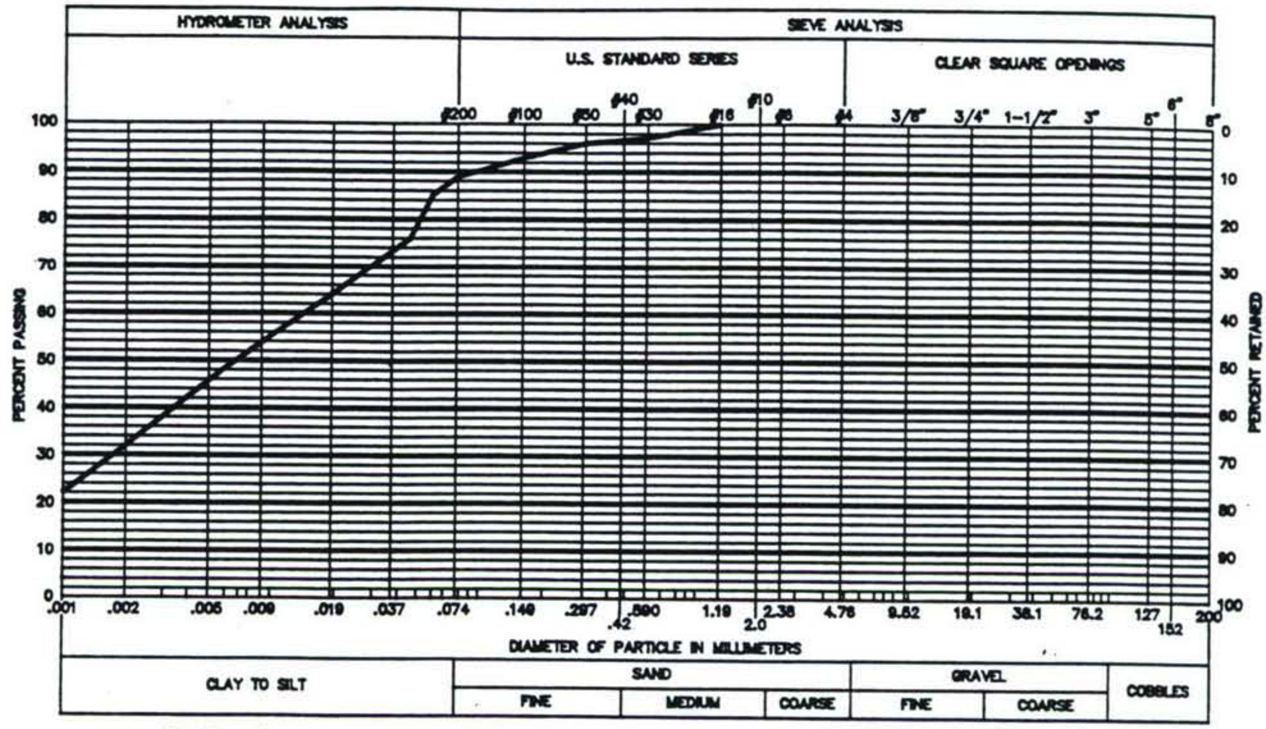
SAMPLE OF SANDY CLAY FROM S-96-92 ● 110-111'



GRAVEL 0 % SAND 19 % SILT AND CLAY 81 %
LIQUID LIMIT 41 PLASTICITY INDEX 17

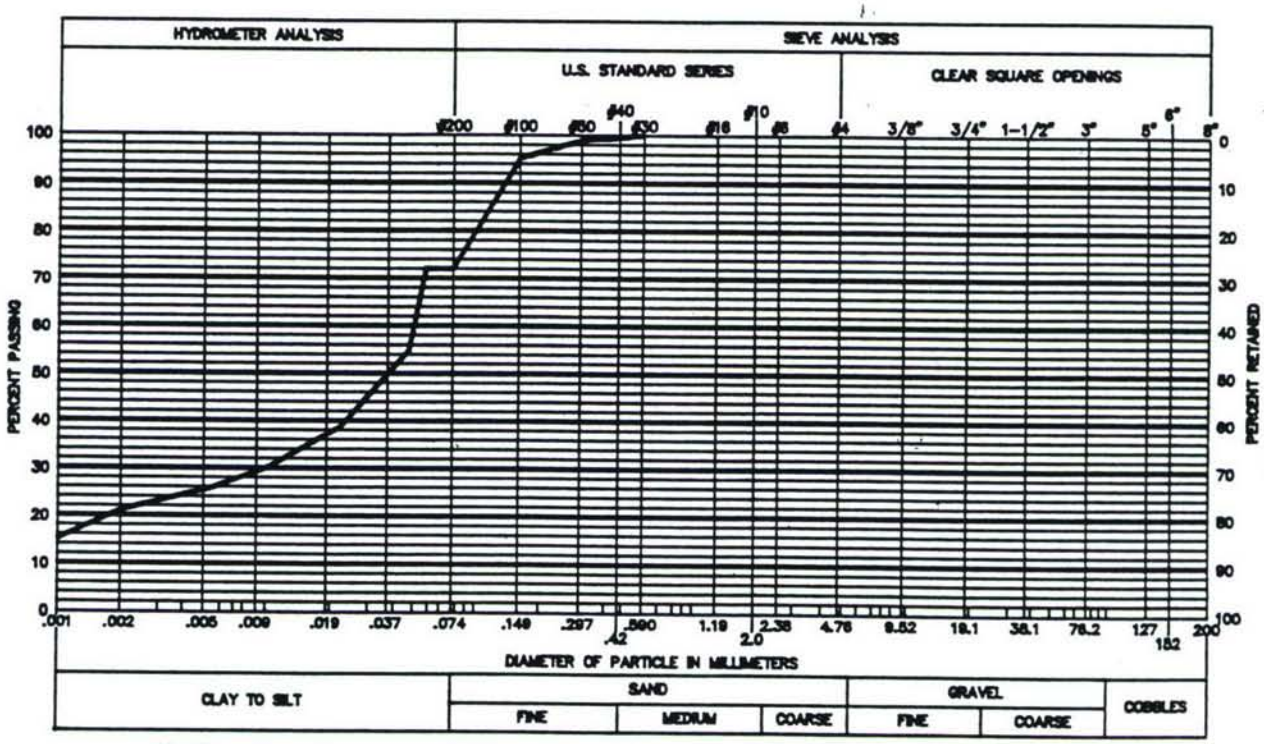
SAMPLE OF SANDY CLAY FROM S-99-92 ● 34-36'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 18



GRAVEL 0 % SAND 10 % SILT AND CLAY 90 %
LIQUID LIMIT 42 PLASTICITY INDEX 18

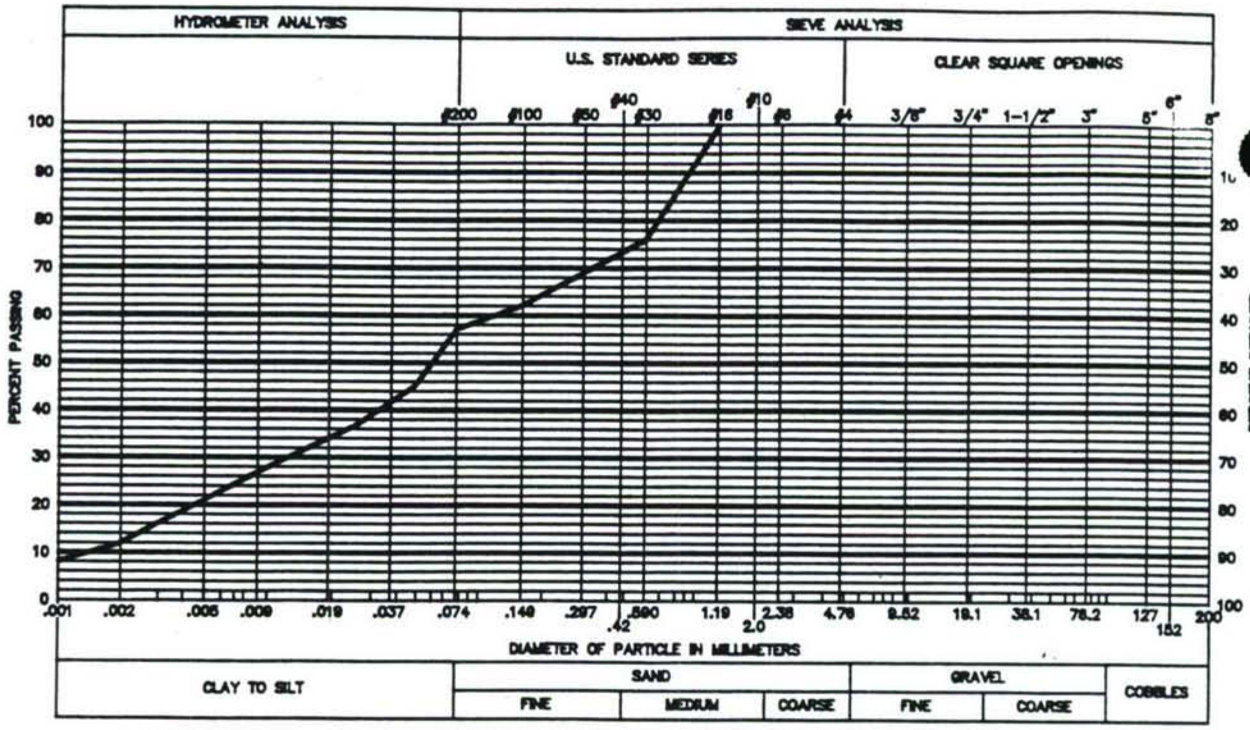
SAMPLE OF SANDY CLAY FROM S-99-92 @ 39-40'



GRAVEL 0 % SAND 28 % SILT AND CLAY 72 %
LIQUID LIMIT 25 PLASTICITY INDEX 6

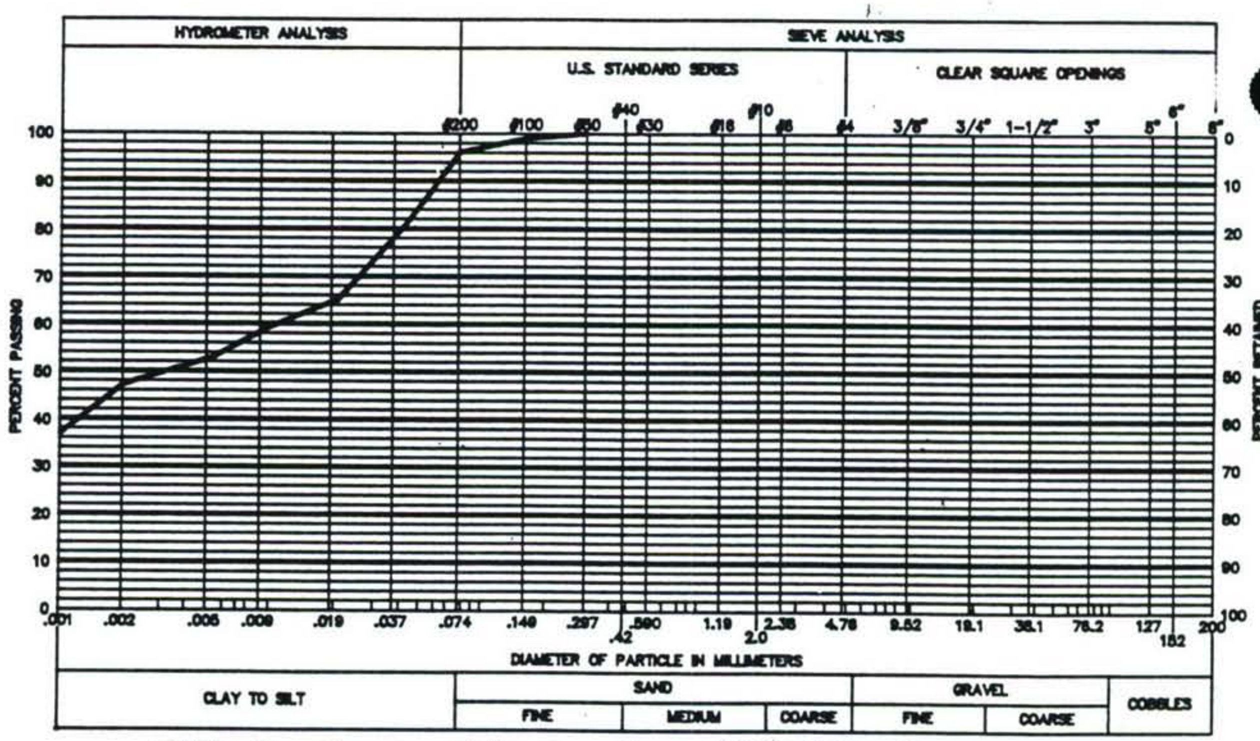
SAMPLE OF SANDY CLAY FROM 25-ODC-108 @ 9-10'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 19



GRAVEL 0 % SAND 42 % SILT AND CLAY 58 %
LIQUID LIMIT 31 PLASTICITY INDEX 6

SAMPLE OF VERY SANDY SILT FROM 01-IAM-13 @ 0'



GRAVEL 0 % SAND 4 % SILT AND CLAY 96 %
LIQUID LIMIT 53 PLASTICITY INDEX 33

SAMPLE OF HIGHLY PLASTIC CLAY FROM 25-ODC-108 @ 4-5'

1 473 93	Chen Northern, Inc.	GRADATION TEST RESULTS	Fig. 20

Chen-Northern, Inc.

MOISTURE & DENSITY WORKSHEET

JOB NO. F7393 PART NO. ______ PREP. BY FD CALC. BY FD DATE 1-20-93

JOB NAME EBASCO, Tooelle Army Depot CKED. BY SU SHEET 1 OF 4

IDENTIFICATION				TEST RESULTS				MOISTURE DETERMINATION				DENSITY DETERMINATION				
HOLE NO.	SAMPLE NO.	DEPTH FEET	SAMPLE TYPE	% MOISTURE	DRY DENSITY PCF	UNIF. CLASS	DESCRIPTION (BLOW COUNT, COMPONENTS, COLOR, MOISTURE CONSISTENCY, STRUCTURE, OTHER)	DISH NO.	WT. OF WET SOIL AND DISH	WT. OF DRY SOIL AND DISH	WT. OF DISH	SAMPLE LENGTH IN.	SAMPLE DIAMETER IN.	WT. OF WET SOIL AND TARE	WT. OF TARE	WT. OF WET SOIL
	1	0'		20.9			01-TA-30-1 or 2 @ 0'	SmaGHA	350.67	331.84	241.55					
	2	0'		14.6			25-AM-58 @ 0'	Pveis	290.9	284.6	241.31					
	3	0'		24.5			01-HBA-84 @ 0'	ACE	304.53	282.96	195.66					
	4	0'		11.1			25-WIND @ 0'	ROY	181.23	176.3	131.83					
	5	4'-5'		18.9			25-AM-58 @ 4'-5'	MINOR	358.52	339.83	240.98					
	6	0'		12.9			25-CT-07 @ 0'	HELP	292.07	286.32	241.69					
	7	4-5'		18.8			25-WIND @ 4-5'	Brookie	315.57	297.26	199.93					
	8	0'		14.9			01-MSD-58 @ 0'	BENT	291.93	285.5	242.26					
	9	0'		16.6			01-IAM-08 @ 0'	TWO	260.13	253.0	209.94					
	10	0'		29.8			01-MD-82 @ 0'	Glop	313.60	296.81	240.46					

JOB NO. 147393 PART NO. ______

JOB NAME EBASCO, Tooelle Army Depot

Chen Northern, Inc.

MOISTURE & DENSITY WORKSHEET

PREP. BY FD CALC. BY FD DATE 4-20-93

CKED. BY SU SHEET 2 OF 4

IDENTIFICATION				TEST RESULTS				MOISTURE DETERMINATION				DENSITY DETERMINATION				
HOLE NO.	SAMPLE NO.	DEPTH FEET	SAMPLE TYPE	% MOISTURE	DRY DENSITY PCF	UNIF. CLASS	DESCRIPTION BLOW COUNT, COMPONENTS, COLOR, MOISTURE CONSISTENCY, STRUCTURE, OTHER	DISH NO.	WT. OF WET SOIL AND DISH	WT. OF DRY SOIL AND DISH	WT. OF DISH	SAMPLE LENGTH IN.	SAMPLE DIAMETER IN.	WT. OF WET SOIL AND TARE	WT. OF TARE	WT. OF WET SOIL
	11	0'		20.3			01-PCA-88 @ 0'	GMC	304.50	286.46	197.58					
	12	0'		14.3			25-1DC-10 @ 0'	RISE	307.56	293.79	197.49					
	13	0-2"		27.6			25-0DC-108 @ 0-2"	Jar	553.6	480.27	256.92					
	14	0'		23.1			01-CP-44 @ 0'	ASH	260.70	251.2	210.03					
	15	39-41'		40.7			5-98-92 @ 39-41'	Violet	243.84	213.19	137.96					
	16	34-36'		25.2			5-98-92 @ 34-36'	PARTY	348.83	327.11	240.91					
	17	74-76'		39.9			5-97-92 @ 74-76'	SPRUCE	312.88	283.09	208.52					
	18	78-81'		33.5			5-97-92 @ 78-81'	UBV	364.41	333.61	241.77					
	19	39-41		32.0			5-102-92 @ 39-41'	BEER	314.95	286.23	196.44					
	20	44-		33.3			5-102-92 @ 44-46'	R.P	325.81	286.77	196.53					

L-3 (5-85)

JOB NO. 47393 PART NO. ______

JOB NAME EBASCO, Tooelle Army Depot

Chen-Northern, Inc.
MOISTURE & DENSITY WORKSHEET

PREP. BY FD CALC. BY FD DATE 4-20-93

CKED. BY SU SHEET 3 OF 4

IDENTIFICATION				TEST RESULTS				MOISTURE DETERMINATION				DENSITY DETERMINATION				
HOLE NO.	SAMPLE NO.	DEPTH FEET	SAMPLE TYPE	% MOISTURE	DRY DENSITY PCF	UNIF. CLASS	DESCRIPTION BLOW COUNT, COMPONENTS, COLOR, MOISTURE CONSISTENCY, STRUCTURE, OTHER	DISH NO.	WT. OF WET SOIL AND DISH	WT. OF DRY SOIL AND DISH	WT. OF DISH	SAMPLE LENGTH IN.	SAMPLE DIAMETER IN.	WT. OF WET SOIL AND TARE	WT. OF TARE	WT. OF WET SOIL
	21	0'		8.2			25-1BA-60 @ 0'	EX8	280.88	277.82	240.6					
	22	9-10'		20.8			25-WIND @ 9-10'	WIN	302.50	283.71	193.22					
	23	67-71		51.5			5-100-92 @ 67-71'	AMOK	309.73	271.65	197.67					
	24	72-74		69.4			5-100-92 @ 72-74'	Romany	344.23	302.11	241.42					
	25	29-31		26.3			5-102-92 @ 29-31'	4	272.12	244.86	141.38					
	26	34-36'		32.5			5-102-92 @ 34-36'	COOT	340.06	308.24	210.22					
	27	44-46'		19.1			5-101-92 @ 44-46'	NEON	345.20	328.51	239.93					
	28	49-50'		25.9			5-101-92 @ 49-50'	YELL	312.93	288.06	192.08					
	29	9-10'		20.0			25-AN-58 @ 9-10'	BRANDY	320.64	305.62	190.51					
	30	144-145.2'		31.2			Test hole (5-93-92) @ 144-145.2'	GILCH	357.14	329.76	242.07					

1-3 (5-85)

JOB NO. 147393 PART NO. ______ **Chen Northern, Inc.** PREP. BY F.D CALC. BY FP DATE 4-20-95

JOB NAME EBASCO, Tooelle Army Depot

MOISTURE & DENSITY WORKSHEET

CKED. BY SU SHEET 4 OF 4

IDENTIFICATION				TEST RESULTS				MOISTURE DETERMINATION				DENSITY DETERMINATION				
HOLE NO.	SAMPLE NO.	DEPTH FEET	SAMPLE TYPE	% MOISTURE	DRY DENSITY PCF	UNIF. CLASS	DESCRIPTION BLOW COUNT, COMPONENTS, COLOR, MOISTURE CONSISTENCY, STRUCTURE, OTHER	DISH NO.	WT. OF WET SOIL AND DISH	WT. OF DRY SOIL AND DISH	WT. OF DISH	SAMPLE LENGTH IN.	SAMPLE DIAMETER IN.	WT. OF WET SOIL AND TARE	WT. OF TARE	WT. OF WET SOIL
	31	148-150		31.9			Test hole (S-93-92) @ 148-150	MAP	333.07	300.91	200.10					
	32	109-111'		38.2			S-95-92 @ 109-111'	Green	248.14	216.10	137.43					
	33	129-131'		~~36.4~~ 38.2			S-95-92 @ 129-131'	HICKS	305.96	275.93	197.37					
	34	109-110'		28.1			S-96-92 @ 109-110'	plaque	322.41	297.15	208.67					
	35	110-111		25.7			S-96-92 @ 110-111'	BO	280.10	272.36	242.14					
	36	34-36'		27.1			S-99-92 @ 34-36'	SHAFT	374.16	345.53	239.72					
	37	39-40		32.6			S-99-92 @ 39-40'	R-5	347.32	321.51	202.44					
	38	9-10'		23.9			25-ODC-108 @ 9-10'	PO	240.61	220.79	137.88					
	39	0'		21.2			01-1AM-13 @ 0'	GEOK	241.89	236.11	194.60					
	40	4-5'		[illegible]4.3			25-ODC-108 @ 4-5'	RAY	353.26	331.41	241.55					

1-3 (5-85)

JOB NO. 147393 PART NO. ______

JOB NAME EBASCO

chen and associates, Inc.

ATTERBERG LIMITS

WORKSHEET

PREP. BY FD CALC. BY I.D DATE 5-13-93

CKED. BY SU SHEET 1 OF 45

HOLE / DEPTH	1				1				1				1				1			
SAMPLE NO. / RUN BY	1 / 1				2 / 1				3 / 1				4 / 1				5 / 1			
PREP. DISH / TRAY LOCAT.	1				1				1				1				1			
NO. OF BLOWS	P.L	29		30	P.L.				P.L	24		25	P.L.				P.L	.28	+	26
DISH NO.	21	55	23	71	N/P		N/P		67	07	23	27	N/P		N/P		51	47	17	65
WT. WET SOIL & DISH	27.11	31.47	21.45	32.82					20.79	38.9	21.24	33.44					21.29	31.81	19.87	34.75
WT. DRY SOIL & DISH	20.24	27.20	20.53	28.18					19.61	31.76	19.90	28.20					20.04	26.99	18.87	29.03
WT. OF DISH	15.70	15.88	15.75	15.92					15.47	15.22	15.14	16.08					15.34	15.66	15.07	15.89
WT. OF WATER	.87	4.27	.92	4.64					1.15	7.14	1.34	5.24					1.25	4.82	1.0	5.72
WT. OF DRY SOIL	14.54	11.25	4.78	12.26					4.14	16.54	4.76	12.12					4.7	11.33	3.8	13.14
WATER CONTENT Wn	89.2	37.9	19.2	37.8					27.8	43.2	28.2	43.2					26.6	42.5	26.3	43.5
LIQUID LIMIT LL		38.6		38.7						43.1		43.2						43		43
PLASTIC INDEX PI	20								15								17			
CLASSIFICATION	LL=39, PI=19 CL								LL=43, PI=15 ML								LL=43, PI=17 CL			

HOLE / DEPTH	1				1				1				1				1			
SAMPLE NO. / RUN BY	6 / 1				7 / 1				8 / 1				9 / 1				10 / 1			
PREP. DISH / TRAY LOCAT.	1				1				1				1				1			
NO. OF BLOWS	P.L	30		24	P.L	25		27	P.L.				P.L.				P.L	.22		23
DISH NO.	55	73	71	21	77	30	27	25	N/P		N/P		N/P		N/P		34	78	09	14
WT. WET SOIL & DISH	22.66	32.00	23.97	32.23	22.5	32.16	18.34	31.89									22.93	34.42	24.85	33.51
WT. DRY SOIL & DISH	21.59	28.30	22.69	28.35	21.34	27.76	16.97	27.57									21.15	29.21	22.82	28.40
WT. OF DISH	15.95	15.79	15.93	15.70	15.44	15.86	11.67	15.82									15.10	15.73	15.78	15.17
WT. OF WATER	1.07	3.7	1.28	3.88	1.16	4.4	1.07	4.32									1.78	5.21	2.03	5.11
WT. OF DRY SOIL	5.64	12.55	6.76	12.65	5.9	11.9	5.3	11.75									6.05	13.48	7.04	13.23
WATER CONTENT Wn	19.	29.5	18.9	30.7	19.7	37	20	36.8									29.4	38.6	28.8	38.6
LIQUID LIMIT LL		30		30.5		37		37										38		38
PLASTIC INDEX PI	11				17												9			
CLASSIFICATION	LL=30, PI=11 CL				LL=37, PI=17												LL=38, PI=9 ML			

JOB NO. 147393 PART NO. ______

JOB NAME EBASCo

chen and associates, Inc.

ATTERBERG LIMITS

WORKSHEET

PREP. BY FD CALC. BY FD DATE 5-13-93

CKED. BY SU SHEET 2 OF 45

HOLE / DEPTH	/				/				/				/				/			
SAMPLE NO. / RUN BY	11 /				12 /				13 /				14 /				15 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L				P.L	24		22	P.L	26		25	P.L	24		25	P.L	28		29
DISH NO.					81	49	61	70	44	58	29	62	47	79	27	23	55	63	71	11
WT. WET SOIL & DISH	W/P		W/P		20.65	35.75	20.98	31.8	21.54	33.14	22.43	40.43	19.9	33.41	8.43	30.74	21.88	38.07	21.32	31.13
WT. DRY SOIL & DISH					19.83	30.34	20.13	27.29	20.65	29.79	21.43	35.56	18.98	28.04	7.56	26.16	20.52	28.85	20.09	24.62
WT. OF DISH					15.64	15.86	15.62	16.03	15.58	16.14	15.91	15.62	15.68	15.13	4.41	15.14	15.96	15.57	15.92	15.31
WT. OF WATER					0.82	5.41	0.85	4.21	.89	3.35	1.0	4.87	0.93	5.37	0.87	4.58	1.36	9.22	1.23	6.51
WT. OF DRY SOIL					4.19	14.48	4.51	11.26	5.07	13.65	5.52	19.94	3.29	12.91	3.15	11.02	4.56	13.28	4.17	9.31
WATER CONTENT Wn					19.6	37.4	18.8	37.4	17.6	24.5	18.1	24.4	28.3	41.6	27.6	41.6	29.8	69.4	29.5	69.9
LIQUID LIMIT LL						37.3		36.8		24.7		24.4		41.4		41.6		70.4		71.1
PLASTIC INDEX PI					18				6				13				41			
CLASSIFICATION					LL=37, PI=18 CL				LL=25, PI=7 CL				LL=41, PI=14 ML				LL=71, PI=41 CH			

HOLE / DEPTH	/				/				/				/				/			
SAMPLE NO. / RUN BY	16 /				17 /				18 /				19 /				20 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L	23		25	P.L	20		24	P.L	28		26	P.L	25		24	P.L	29		27
DISH NO.	28	80	34	35	35	80	11	63	67	07	23	27	14	29	64	25	40	07	48	56
WT. WET SOIL & DISH	22.20	38.93	22.60	30.23	21.70	31.63	21.67	28.23	21.39	[illegible]	21.66	32.33	20.14	32.19	21.18	36.42	22.97	33.15	22.26	34.61
WT. DRY SOIL & DISH	20.96	30.50	21.15	24.73	20.4	26.7	20.44	24.41	20.30	28.50	20.46	27.19	18.98	26.81	19.88	29.91	21.03	27.76	20.66	28.77
WT. OF DISH	15.73	15.74	15.10	15.02	15.01	15.75	15.31	15.57	15.46	15.21	15.13	16.07	15.17	15.24	15.59	15.81	15.09	15.21	15.67	15.35
WT. OF WATER	1.24	8.43	1.45	5.5	1.3	4.93	1.23	3.82	1.09	6.0	1.2	5.14	1.16	5.38	.3	6.51	1.94	5.39	1.6	5.84
WT. OF DRY SOIL	5.23	14.76	6.05	9.71	[illegible]	10.95	5.13	8.84	4.84	13.29	5.33	11.12	3.81	11.57	4.29	14.1	5.94	12.55	4.99	13.42
WATER CONTENT Wn	23.7	57.1	23.9	56.6	24.1	[illegible]	24.0	43.2	22.5	45.1	22.5	46.2	30.4	46.5	30.3	46.1	32.7	42.9	32.1	43.5
LIQUID LIMIT LL		56.5		56.6		43.9		43		45.8		46.4	46					43.7		43.9
PLASTIC INDEX PI	33				19				24				16							
CLASSIFICATION	LL=57, PI=33 CH				LL=43, PI=19 CL				LL=46, PI=24 CL				LL=46, PI=16 ML				LL=44, PI= [illegible] ML			

JOB NO. 47393 PART NO. ______

JOB NAME EBASCO

chen and associates, Inc.

ATTERBERG LIMITS

WORKSHEET

PREP. BY F.D CALC. BY FD DATE 5-14-93

CKED. BY ______ SHEET 3 OF 15

HOLE / DEPTH	/				/				/				/				/			
SAMPLE NO. / RUN BY	21 /				22 /				23 /				24 /				25 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L.				P.L.	23		24	P.L.	27		25	P.L.	25		26	P.L.	25		28
DISH NO.	N/P		N/P		32	76	41	77	30	20	26	09	26	73	30	21	39	63	64	62
WT. WET SOIL & DISH					16.24	32.2	19.84	33.10	22.01	34.54	22.10	35.01	21.89	32.6	21.65	32.52	20.58	29.98	20.72	33.14
WT. DRY SOIL & DISH					15.26	27.76	18.21	28.26	20.20	27.63	20.24	27.54	20.44	25.60	20.27	25.53	19.47	25.67	19.67	28.06
WT. OF DISH					10.74	16.03	10.90	15.44	15.85	15.78	15.79	15.23	15.79	15.76	15.86	15.70	15.25	15.58	15.60	15.61
WT. OF WATER					0.98	4.44	1.63	4.84	1.81	6.91	1.86	7.47	1.45	7.0	1.38	6.99	1.11	4.31	1.05	5.08
WT. OF DRY SOIL					4.52	11.73	7.31	12.82	4.35	11.85	4.45	12.31	4.65	9.84	4.41	9.83	4.22	10.09	4.07	12.45
WATER CONTENT Wn					21.7	37.9	22.3	37.7	41.6	58.3	41.8	~~56.9~~	31.2	71.1	31.3	71.1	26.3	42.7	25.8	40.8
LIQUID LIMIT LL						37.5		37.6		58.8		60.7		71		71		42.7		41
PLASTIC INDEX PI					15				17				40				21			
CLASSIFICATION					LL=38, PI=16 CL				LL=60, PI=18 MH				LL=71, PI=40 CH				LL=42, PI=16 ML			

HOLE / DEPTH	/				/				/				/				/			
SAMPLE NO. / RUN BY	26 /				27 /				28 /				29 /				30 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L.	28		27	P.L.	27		25	P.L.	23		25	P.L.	23		26	25	PL	23	PL
DISH NO.	29	47	33	65	11	20	35	81	80	51	26	49	29	024	33	65	A21	17	23	51
WT. WET SOIL & DISH	21.88	32.14	22.28	33.38	21.22	34.44	19.47	33.11	20.18	39.44	21.28	32.57	21.90	35.72	22.17	35.62	30.84	22.24	32.9	21.79
WT. DRY SOIL & DISH	20.41	28.16	20.72	28.76	20.30	28.93	18.79	28.09	19.35	29.99	20.24	28.06	20.74	30.68	20.98	30.73	25.55	20.82	26.87	20.41
WT. OF DISH	15.13	15.66	15.16	15.69	15.35	15.23	15.02	15.65	15.76	15.34	15.79	15.86	15.13	15.73	15.16	15.89	15.70	15.07	15.75	15.34
WT. OF WATER	1.47	4.48	1.56	4.62	.92	5.51	0.68	5.02	0.83	5.45	1.04	4.51	1.16	5.04	1.19	4.89	5.29	1.42	6.03	1.29
WT. OF DRY SOIL	5.28	12.5	5.56	12.87	4.95	13.7	3.77	12.44	3.59	14.65	4.45	12.2	5.61	14.95	5.82	14.85	9.85	5.75	11.12	5.07
WATER CONTENT Wn	27.8	35.8	28.1	35.9	18.6	40.2	18.0	40.4	23.1	37.2	23.4	37	20.7	33.7	20.4	32.9	53.7	24.7	~~54.2~~	25.4
LIQUID LIMIT LL		36.3		36.2		40.6		40.4		37		37		33.4		33	53.7		~~54.0~~ 53.7	
PLASTIC INDEX PI	8				22				15				13				29			
CLASSIFICATION	LL=36, PI=8 ML				LL=40, PI=22 CL				LL=37, PI=14 CL				LL=33, PI=13 CL				LL=54, PI=29 CH			

JOB NO. 17393 PART NO. ______

JOB NA[ME] EBASCO

chen and associates, Inc.

ATTERBERG LIMITS

WORKSHEET

PREP. BY E.D CALC. BY ______ DATE ______

CKED. BY ______ SHEET 4 OF 5

HOLE / DEPTH	Wrong Sample,				/				/				/				/			
SAMPLE NO. / RUN BY	31 see Page 5				32 /				33 /				34 /				35 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L	28		23	P.L	29		30	P.L	28		26	P.L	29		27	P.L	28		26
DISH NO.	27	26	73	39	51	20	09	17	20	17	51	26	39	34	64	09	25	78	30	14
WT. WET SOIL & DISH	23.58	33.13	25.10	33.30	23.88	33.96	24.13	30.69	21.86	36.09	23.08	32.06	21.0	33.04	22.5	30.22	22.44	33.30	22.14	32.60
WT. DRY SOIL & DISH	21.97	29.57	23.18	29.57	22.10	26.02	22.41	24.06	20.55	28.89	21.55	26.45	19.89	25.81	21.14	24.30	21.46	28.8	21.2	28.13
WT. OF DISH	15.71	15.79	15.75	15.86	15.34	15.23	15.78	15.06	15.23	15.06	15.34	15.79	15.24	15.1	15.60	15.78	15.82	15.73	15.86	15.17
WT. OF WATER	1.56	3.56	1.92	3.73	1.78	7.94	1.72	6.61	1.31	7.2	1.53	5.61	1.11	7.23	1.36	5.92	.98	4.5	.94	4.47
WT. OF DRY SOIL	6.28	13.78	7.43	13.71	6.76	10.79	6.63	9.0	5.32	13.83	6.21	10.66	4.63	10.71	5.54	8.52	5.64	13.07	5.34	12.96
WATER CONTENT Wn	24.8	25.8	25.8	27.2	26.3	73.6	25.9	73.41	24.6	52.1	24.6	52.6	23.9	67.5	24.5	69.5	17.4	34.4	17.6	34.5
LIQUID LIMIT LL		26.2		26.9		74.9		75.13		52.8		52.9		69.67		70.1		34.7		34.7
PLASTIC INDEX PI	1.0				49				26				46				18			
CLASSIFICATION	LL=27, PI=1 ML				LL=75, PI=49 CH				LL=53, PI=28 CH				LL=69, PI=45 CH				LL=35, PI=17 CL			

HOLE / DEPTH	/				/				/				/				/			
SAMPLE NO. / RUN BY	36 /				37 /				38 /				39 /				40 /			
PREP. DISH / TRAY LOCAT.	/				/				/				/				/			
NO. OF BLOWS	P.L	24		22	P.L	21		22	P.L	23		25	P.L	27		25	P.L	28		28
DISH NO.	44	32	41	29	75	65	67	58	23	27	47	67	56	40	07	48	33	17	20	26
WT. WET SOIL & DISH	20.71	28.83	15.89	35.58	20.45	33.34	20.22	30.73	21.11	35.82	22.62	33.40	21.40	34.99	22.43	32.87	19.87	36.28	21.01	32.2
WT. DRY SOIL & DISH	19.73	23.55	14.95	29.81	19.60	29.47	19.30	26.34	20.13	31.78	21.48	29.77	20.18	30.30	20.96	28.80	19.09	28.95	20.19	26.52
WT. OF DISH	15.58	10.74	10.9	15.91	16.04	15.89	15.47	16.14	15.13	16.07	15.66	15.46	15.36	15.10	15.22	15.67	15.16	15.07	16.4	15.62
WT. OF WATER	.98	5.28	.94	5.77	.85	5.87	.92	4.39	.98	4.04	1.14	3.63	1.22	4.69	1.47	4.07	.78	7.33	.82	5.68
WT. OF DRY SOIL	4.15	12.81	4.05	13.9	3.56	13.58	3.83	10.2	5.0	15.71	5.82	14.31	4.82	15.2	5.74	13.13	3.93	13.88	4.15	10.9
WATER CONTENT Wn	23.6	41.2	23.2	41.5	23.9	43.2	24.	43	19.6	25.7	19.6	25.4	25.3	30.9	25.6	31	19.8	52.8	19.8	52.1
LIQUID LIMIT LL		41		40.9		42.3		42.4		25.5		25.4		31		31		53.5		52.24
PLASTIC INDEX PI	18				18				6				6				32			
CLASSIFICATION	LL=41, PI=17 CL				LL=42, PI=18 CL				LL=25, PI=6 ML-CL				LL=31, PI=6 ML				LL=53, PI=33 CH			

Chen Northern, Inc.

ATTERBERG, -200, MOISTURE & DENSITY WORKSHEET

LAB NO. ______

JOB NO. 147393 PART NO. ______ PREP. BY S. Urton DATE 5-24-93

JOB NAME EBASCO, Tooele Army Depot CALC. BY ______ CKED. BY ______

HOLE NO. ______ DEPTH ______ SAMPLE NO. 31

SAMPLE DESCRIPTION ______ COLOR ______

ATTERBERG LIMITS

PREP. DISH OAK RUN BY ______

	PL	LL
NO. OF BLOWS	—	20
DISH NO.	30	56
WT. OF WET SOIL & DISH	19.63	40.44
WT. OF DRY SOIL & DISH	18.96	30.53
WT. OF DISH	15.86	15.35
WT. OF WATER	0.67	9.91
WT. OF DRY SOIL	3.10	15.18
WATER CONTENT	21.61	65.28

LIQUID LIMIT, LL 63.58

PLASTIC INDEX, PI 41.97

ATTERBERG LIMITS

PREP. DISH OAK RUN BY ______

	PL	LL
NO. OF BLOWS	—	27
DISH NO.	73	26
WT. OF WET SOIL & DISH	19.92	33.94
WT. OF DRY SOIL & DISH	19.15	26.85
WT. OF DISH	15.75	15.79
WT. OF WATER	0.77	7.09
WT. OF DRY SOIL	3.40	11.06
WATER CONTENT	22.64	64.10

LIQUID LIMIT, LL 64.67

PLASTIC INDEX, PI 42.03

(LL=64
PI=42)

MOISTURE CONTENT

RUN BY ______

DISH NO.	
WT. OF DISH & WET SOIL	
WT. OF DISH & DRY SOIL	
WT. OF DISH	
WT. OF WATER	
WT. OF DRY SOIL	

MOISTURE CONTENT ______ %

-200

RUN BY ______

DISH NO.	
WT. OF DISH & DRY SOIL	
WT. OF DISH & WASHED SOIL	
WT. OF DISH	
WT. OF -200	
WT. OF TOTAL SOIL, DRY	
PERCENT -200	%

DATE IN: ______ SUPERVISOR: ______

LOCATION: ______

REMARKS: ______

L-7 (5-85)

pH TEST
WORKSHEET

JOB NO. 147393 PART NO. ______ RUN BY F.D DATE 5-24-93
JOB NAME EBASCO CALC. BY ______ CKED. BY ______

SOIL pH MEASURED IN 0.01M $CaCl_2$ ✳

HOLE NO. ______ DEPTH ______ SAMPLE NO. 1 DESCRIPTION ______	TEST NO. ______ pH = 9.019
HOLE NO. ______ DEPTH ______ SAMPLE NO. 2 DESCRIPTION ______	TEST NO. ______ pH = 9.983
HOLE NO. ______ DEPTH ______ SAMPLE NO. 3 DESCRIPTION ______	TEST NO. ______ pH = 7.970
HOLE NO. ______ DEPTH ______ SAMPLE NO. 4 DESCRIPTION ______	TEST NO. ______ pH = 9.450
HOLE NO. ______ DEPTH ______ SAMPLE NO. 5 DESCRIPTION ______	TEST NO. ______ pH = 9.76[illegible]
HOLE NO. ______ DEPTH ______ SAMPLE NO. 6 DESCRIPTION ______	TEST NO. ______ pH = 8.875
HOLE NO. ______ DEPTH ______ SAMPLE NO. 7 DESCRIPTION ______	TEST NO. ______ pH = 8.499
HOLE NO. ______ DEPTH ______ SAMPLE NO. 8 DESCRIPTION ______	TEST NO. ______ pH = 7.596

Remarks ✳ NOTE IF DISTILLED WATER WAS USED INSTEAD OF $CaCl_2$ SOLUTION.

L-21 (5-85)

pH TEST
WORKSHEET

JOB NO. 147393 PART NO. ________ RUN BY F.D DATE 5-25-93
JOB NAME EBASCO CALC. BY ________ CKED. BY ________

SOIL pH MEASURED IN 0.01M $CaCl_2$ *

HOLE NO. ____ DEPTH ____ SAMPLE NO. 9 DESCRIPTION ____	TEST NO. ____ pH= 8.984
HOLE NO. ____ DEPTH ____ SAMPLE NO. 10 DESCRIPTION ____	TEST NO. ____ pH= 8.413
HOLE NO. ____ DEPTH ____ SAMPLE NO. 11 DESCRIPTION ____	TEST NO. ____ pH= 8.590
HOLE NO. ____ DEPTH ____ SAMPLE NO. 12 DESCRIPTION ____	TEST NO. ____ pH= 8.242
HOLE NO. ____ DEPTH ____ SAMPLE NO. 13 DESCRIPTION ____	TEST NO. ____ pH= 7.719
HOLE NO. ____ DEPTH ____ SAMPLE NO. 14 DESCRIPTION ____	TEST NO. ____ pH= 8.383
HOLE NO. ____ DEPTH ____ SAMPLE NO. 15 DESCRIPTION ____	TEST NO. ____ pH= 8.349
HOLE NO. ____ DEPTH ____ SAMPLE NO. 16 DESCRIPTION ____	TEST NO. ____ pH= 8.560

Remarks * NOTE IF DISTILLED WATER WAS USED INSTEAD OF $CaCl_2$ SOLUTION.

Chen & Northern, Inc.

pH TEST WORKSHEET

JOB NO. 14793 PART NO. ______ RUN BY F.D DATE 5-26-93
JOB NAME EBASCO CALC. BY ______ CKED. BY ______

SOIL pH MEASURED IN 0.01M $CaCl_2$ *

HOLE NO.	DEPTH	SAMPLE NO.	DESCRIPTION	TEST NO.	pH=
		17			8.379
		18			8.099
		19			8.190
		20			8.229
		21			9.542
		22			8.161
		23			8.250
		24			8.156

Remarks * NOTE IF DISTILLED WATER WAS USED INSTEAD OF $CaCl_2$ SOLUTION.

L-21 (5-85)

Chen-Northern, Inc.

pH TEST
WORKSHEET

JOB NO. 14393 PART NO. ______ RUN BY F.D DATE 5-27-93
JOB NAME EBR800 CALC. BY ______ CKED. BY ______

SOIL pH MEASURED IN 0.01M $CaCl_2$ *

HOLE NO.	DEPTH	SAMPLE NO.	DESCRIPTION	TEST NO.	pH=
		25			8.200
		26			8.389
		27			8.165
		28			8.384
		29			8.757
		30			6.489
		31			8.843
		32			8.483

Remarks * NOTE IF DISTILLED WATER WAS USED INSTEAD OF $CaCl_2$ SOLUTION.

L-21 (5-85)

pH TEST
WORKSHEET

JOB NO. 147393 PART NO. ________ RUN BY F.D DATE 5-24-93
JOB NAME EBASCO ________ CALC. BY ________ CKED. BY ________

SOIL pH MEASURED IN 0.01M $CaCl_2$ ✱

HOLE NO. ____ DEPTH ____ SAMPLE NO. 33 DESCRIPTION ____	TEST NO. ____ pH= 7.926
HOLE NO. ____ DEPTH ____ SAMPLE NO. 34 DESCRIPTION ____	TEST NO. ____ pH= 8.804
HOLE NO. ____ DEPTH ____ SAMPLE NO. 35 DESCRIPTION ____	TEST NO. ____ pH= 9.176
HOLE NO. ____ DEPTH ____ SAMPLE NO. 36 DESCRIPTION ____	TEST NO. ____ pH= 8.677
HOLE NO. ____ DEPTH ____ SAMPLE NO. 37 DESCRIPTION ____	TEST NO. ____ pH= 8.318
HOLE NO. ____ DEPTH ____ SAMPLE NO. 38 DESCRIPTION ____	TEST NO. ____ pH= 9.248
HOLE NO. ____ DEPTH ____ SAMPLE NO. 39 DESCRIPTION ____	TEST NO. ____ pH= 9.596
HOLE NO. ____ DEPTH ____ SAMPLE NO. 40 DESCRIPTION ____	TEST NO. ____ pH= 9.063

Remarks ✱ NOTE IF DISTILLED WATER WAS USED INSTEAD OF $CaCl_2$ SOLUTION.

L-21 (5-85)

APPENDIX B

SLUG TEST DATA

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:06:42

==

TEST DESCRIPTION

```
Data set........... 4b.inp
Data set title..... Slug Withdrawal Test Well S -  4
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/9/93

Knowns and Constants:
   No. of data points................... 273
   Radius of well casing................ 0.193
   Radius of well....................... 0.417
   Aquifer saturated thickness.......... 200
   Well screen length................... 20
   Static height of water in well....... 27.46
   Log(Re/Rw)........................... 2.59
   A, B, C..............................  3.011,  0.485,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

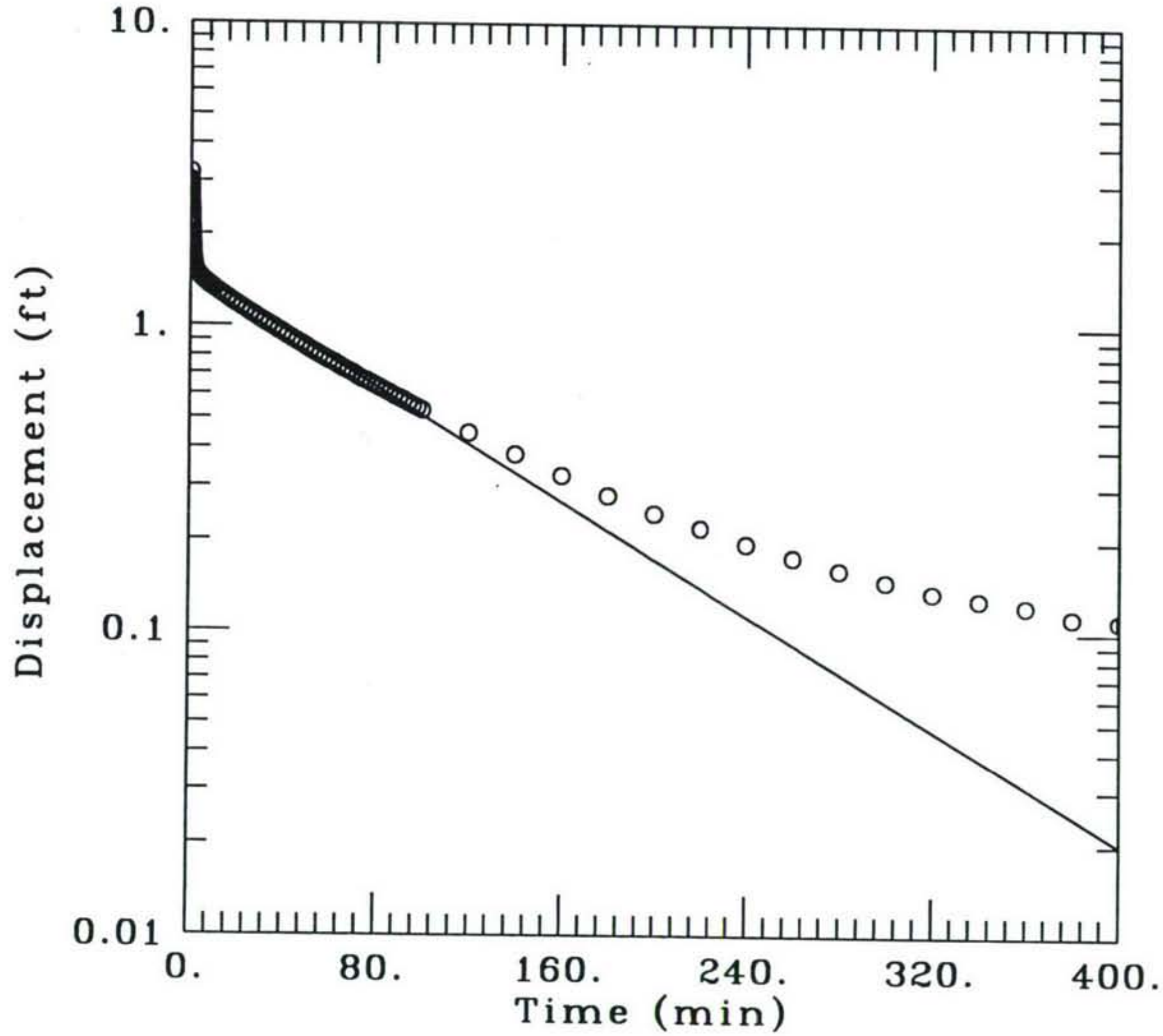
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
        Estimate
  K  =  2.6011E-005
  y0 =  1.5035E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 4



DATA SET:
4b.inp
01/04/94

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
2/9/93

ESTIMATED PARAMETERS:
K = 2.6011E-05 ft/min
y0 = 1.504 ft

TEST DATA:
H0 = 3.196 ft
rc = 0.193 ft
rw = 0.417 ft
L = 20. ft
b = 200. ft
H = 27.46 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:11:06

==

TEST DESCRIPTION

```
Data set........... 5b.inp
Data set title..... Slug Withdrawal Test Well S -  5
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/8/93

Knowns and Constants:
   No. of data points.................. 181
   Radius of well casing............... 0.193
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 20
   Static height of water in well...... 24.9
   Log(Re/Rw).......................... 2.548
   A, B, C.............................  3.011,  0.485,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

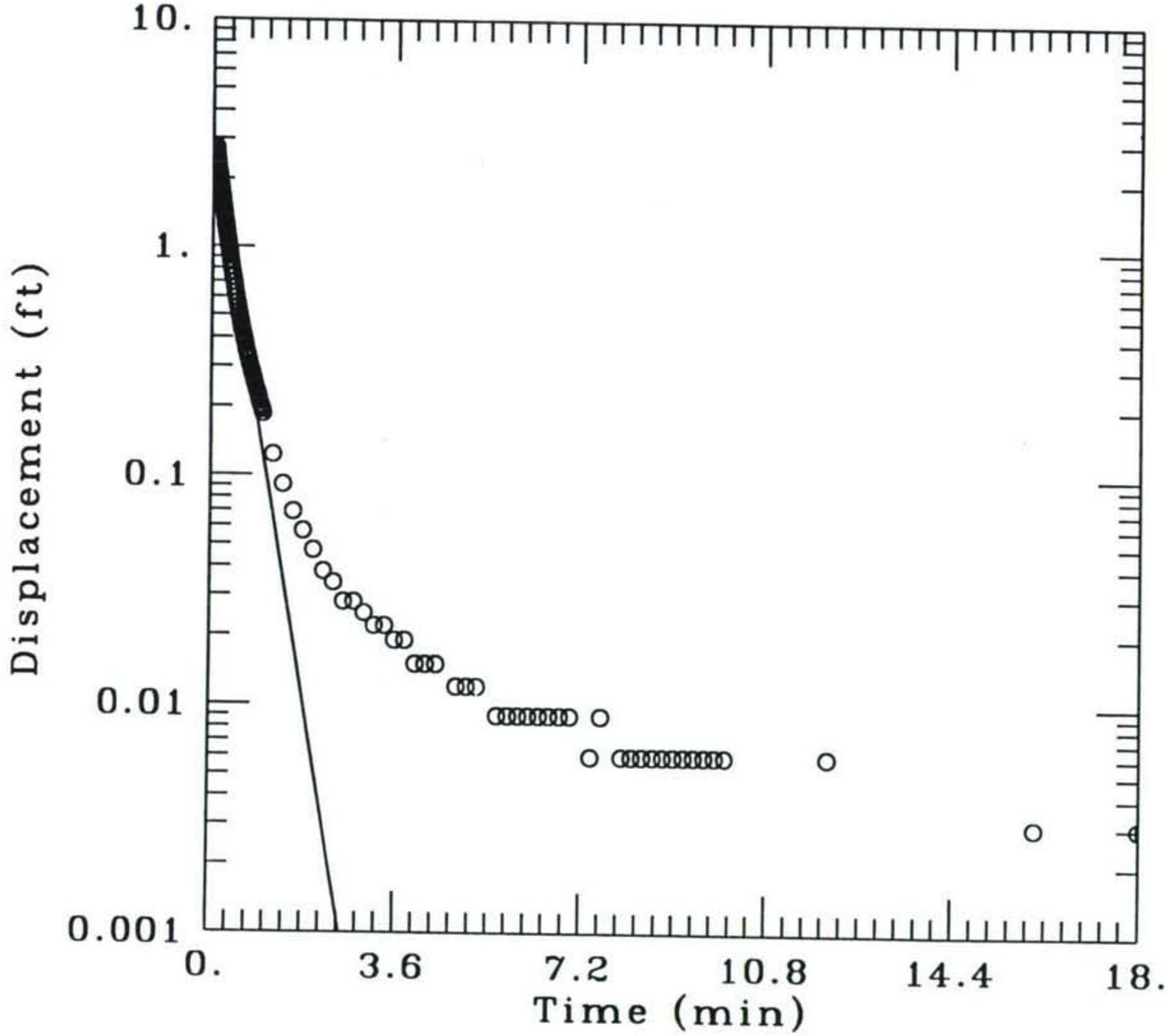
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
        Estimate
  K  =  7.3130E-003
  y0 =  2.7534E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 5



DATA SET:
5b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/8/93

ESTIMATED PARAMETERS:
K = 0.007313 ft/min
y0 = 2.753 ft

TEST DATA:
H0 = 2.725 ft
rc = 0.193 ft
rw = 0.417 ft
L = 20. ft
b = 200. ft
H = 24.9 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 11:19:52

==
TEST DESCRIPTION

```
Data set........... 18b.inp
Data set title..... Slug Withdrawal Test Well S - 18
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/18/93

Knowns and Constants:
   No. of data points.................. 233
   Radius of well casing............... 0.248
   Radius of well...................... 0.375
   Aquifer saturated thickness......... 200
   Well screen length.................. 17.02
   Static height of water in well...... 17.02
   Log(Re/Rw).......................... 2.407
   A, B, C.............................  2.930,  0.473,  0.000
```

==
ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
          Estimate
  K  =   1.5024E-004
  y0 =   2.0773E+000
```

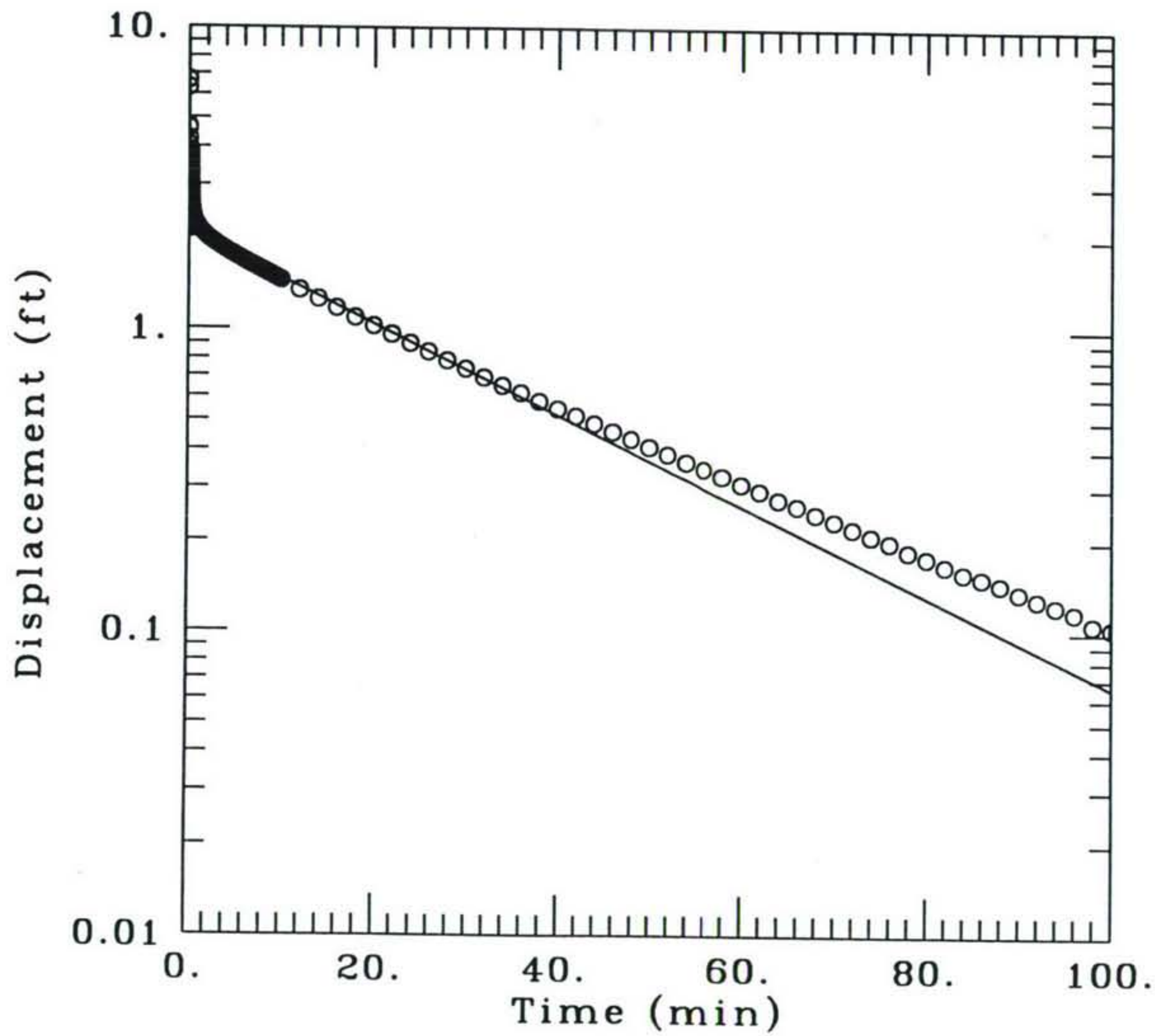
EBASCO

Client: USAEC

Project No.: TEAD-S

Location: SWMU 25

Slug Withdrawal Test Well S - 18



DATA SET:
18b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/18/93

ESTIMATED PARAMETERS:
K = 0.0001502 ft/min
y0 = 2.077 ft

TEST DATA:
H0 = 6.673 ft
rc = 0.248 ft
rw = 0.375 ft
L = 17.02 ft
b = 200. ft
H = 17.02 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/05/94 10:06:32

==

TEST DESCRIPTION

Data set........... 19b.inp
Data set title..... Bail Down Recovery Test Well S - 19
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/11/93

Knowns and Constants:
No. of data points.................. 26
Radius of well casing............... 0.248
Radius of well...................... 0.333
Aquifer saturated thickness......... 200
Well screen length.................. 2.69
Static height of water in well...... 2.69
Log(Re/Rw).......................... 1.062
A, B, C............................. 1.848, 0.251, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	6.0823E-003
y0 =	7.4989E-002

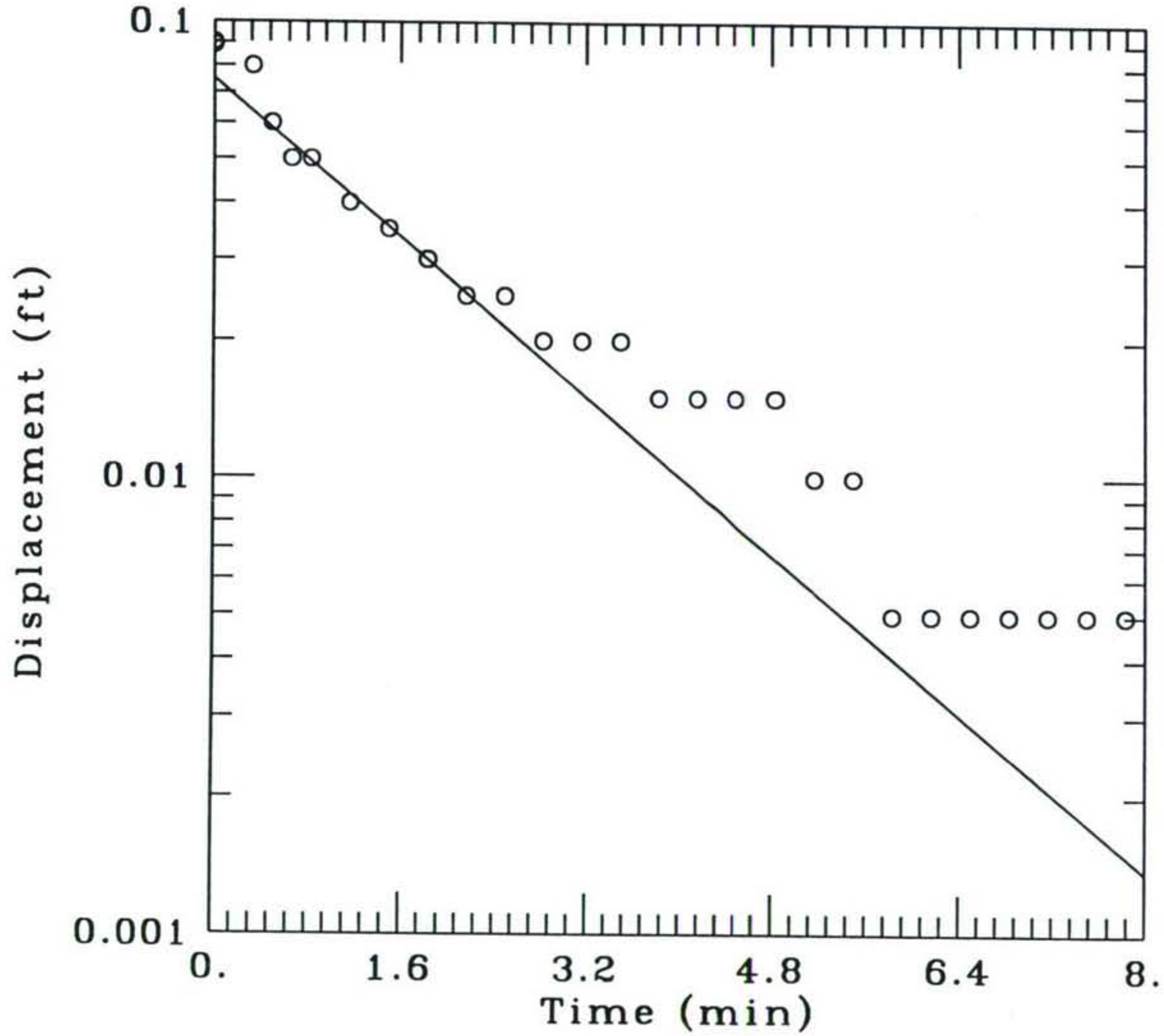
EBASCO

Client: USAEC

Project No.: TEAD-S

Location: SWMU 25

Bail Down Recovery Test Well S - 19



DATA SET:
19b.inp
01/05/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/11/93

ESTIMATED PARAMETERS:
K = 0.006082 ft/min
y0 = 0.07499 ft

TEST DATA:
H0 = 0.09 ft
rc = 0.248 ft
rw = 0.333 ft
L = 2.69 ft
b = 200. ft
H = 2.69 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:17:59

===

TEST DESCRIPTION

Data set........... 64b.inp
Data set title..... Slug Withdrawal Test Well S - 64
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/10/93

Knowns and Constants:
No. of data points................... 224
Radius of well casing............... 0.167
Radius of well...................... 0.417
Aquifer saturated thickness......... 200
Well screen length.................. 10
Static height of water in well...... 13.37
Log(Re/Rw).......................... 1.991
A, B, C............................. 2.262, 0.363, 0.000

===

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

===

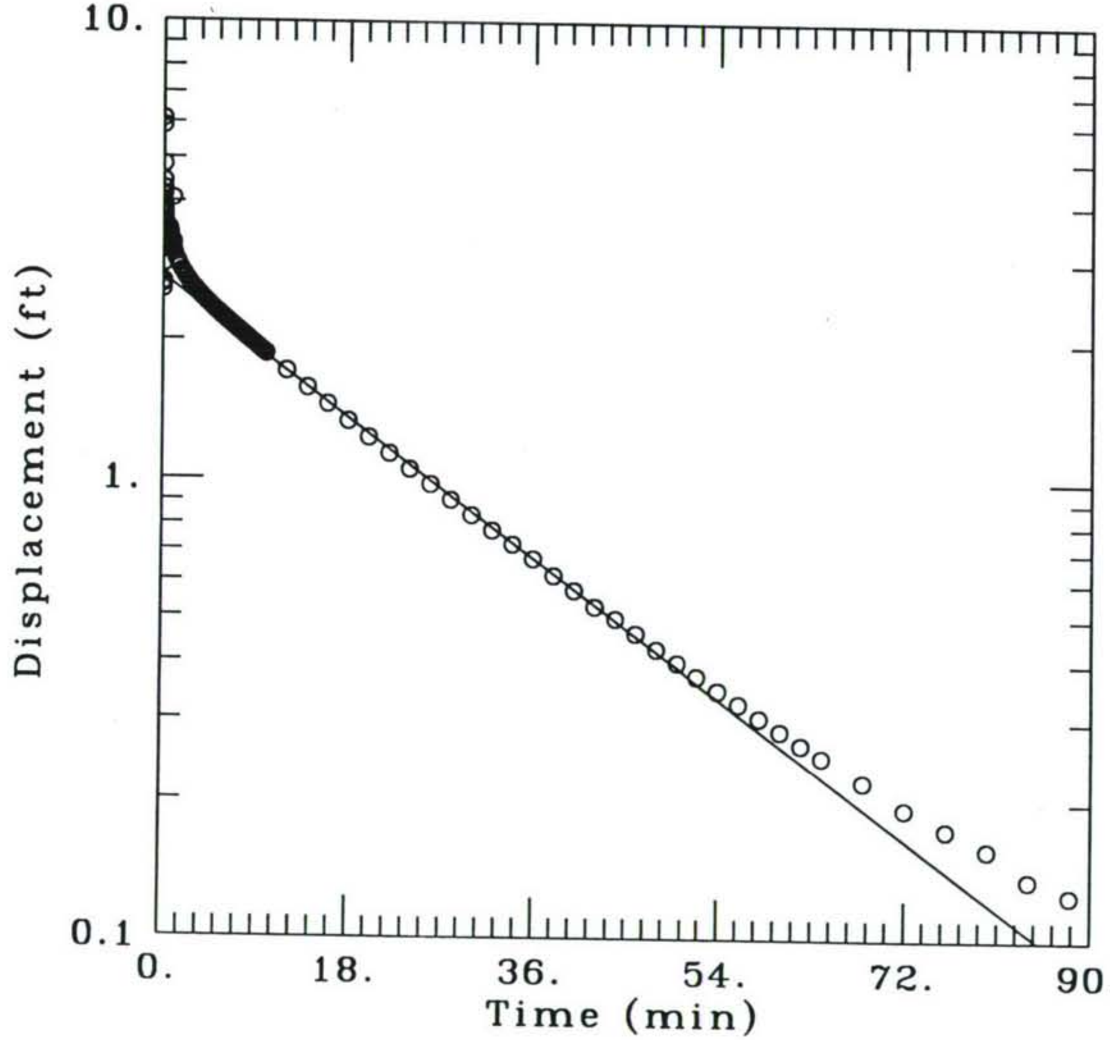
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	1.0818E-004
y0 =	2.7369E+000

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 64



DATA SET:
64b.inp
01/04/94

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
2/10/93

ESTIMATED PARAMETERS:
K = 0.0001082 ft/min
y0 = 2.737 ft

TEST DATA:
H0 = 6.084 ft
rc = 0.167 ft
rw = 0.417 ft
L = 10. ft
b = 200. ft
H = 13.37 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:25:32

==

TEST DESCRIPTION

Data set........... 65b.inp
Data set title..... Slug Withdrawal Test Well S - 65
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/11/93

Knowns and Constants:
No. of data points.................. 219
Radius of well casing............... 0.268
Radius of well...................... 0.417
Aquifer saturated thickness......... 200
Well screen length.................. 8.89
Static height of water in well...... 8.89
Log(Re/Rw).......................... 1.788
A, B, C............................. 2.186, 0.346, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

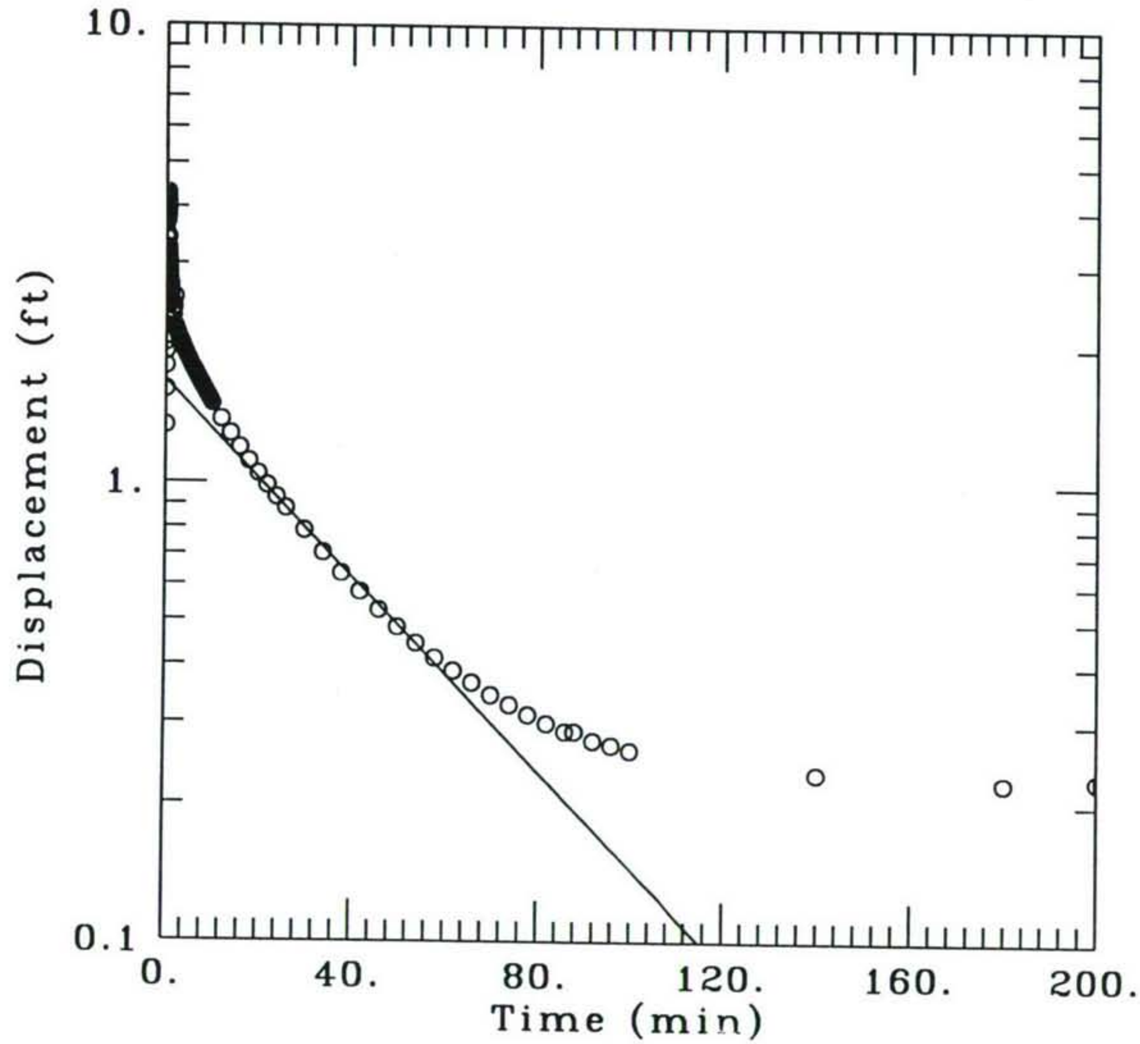
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	1.7666E-004
y0 =	1.6692E+000

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 65



DATA SET:
65b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/11/93

ESTIMATED PARAMETERS:
K = 0.0001767 ft/min
y0 = 1.669 ft

TEST DATA:
H0 = 4.007 ft
rc = 0.268 ft
rw = 0.417 ft
L = 8.89 ft
b = 200. ft
H = 8.89 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:38:33

==

TEST DESCRIPTION

```
Data set........... 66b.inp
Data set title..... Slug Withdrawal Test Well S - 66
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/10/93

Knowns and Constants:
   No. of data points.................. 200
   Radius of well casing............... 0.161
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 10
   Static height of water in well...... 57.59
   Log(Re/Rw).......................... 2.464
   A, B, C. ...........................  2.262,  0.363,  0.000
```

==

ANALYTICAL METHOD

Bou... -Rice (Unconfined Aquifer Slug Test)

==

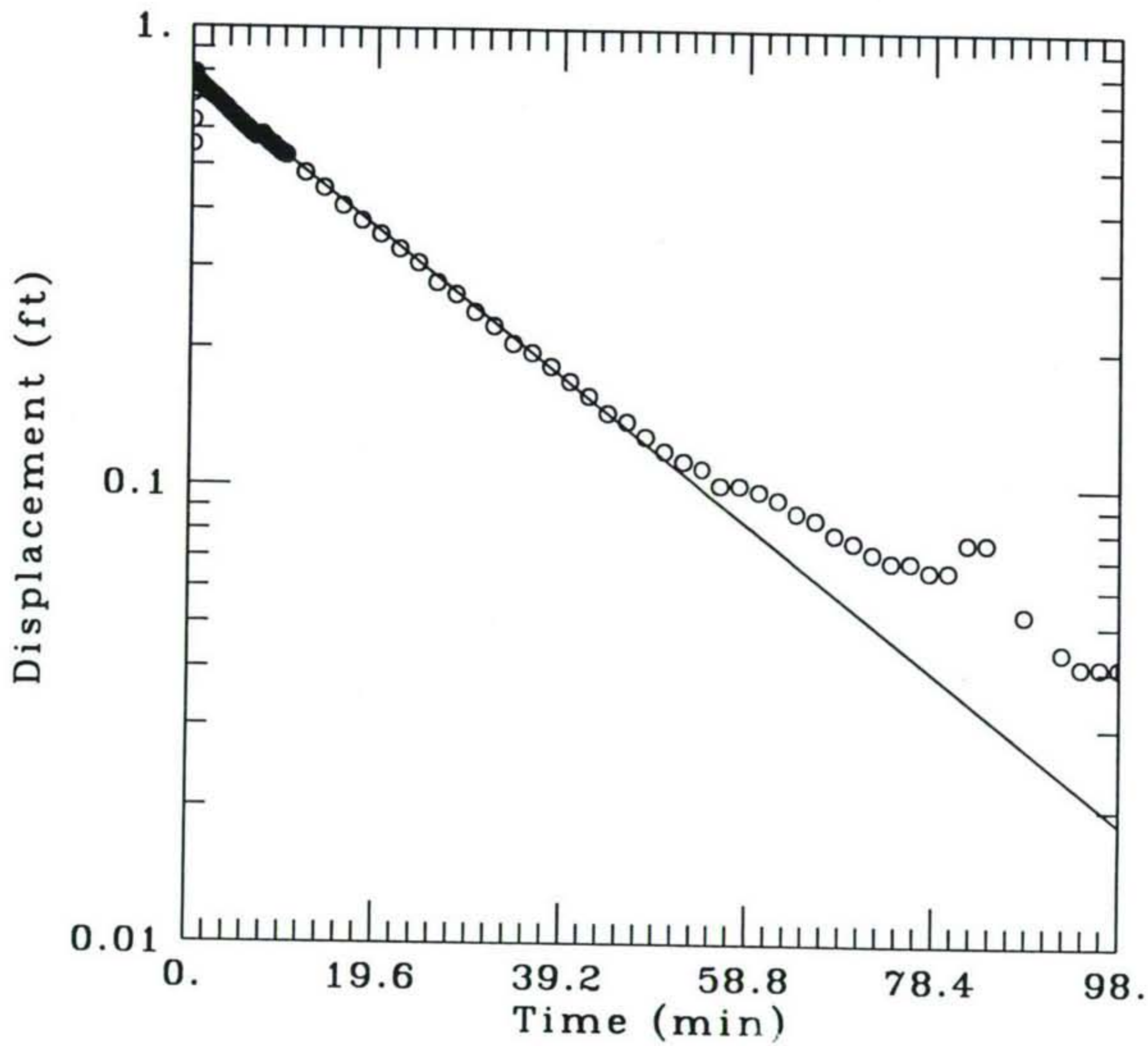
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	1.2118E-004
y0 =	7.6933E-001

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 66



DATA SET:
66b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/10/93

ESTIMATED PARAMETERS:
K = 0.0001212 ft/min
y0 = 0.7693 ft

TEST DATA:
H0 = 0.788 ft
rc = 0.161 ft
rw = 0.417 ft
L = 10. ft
b = 200. ft
H = 57.59 ft

A Q T E S O L V   R E S U L T S

Version 1.10

03/31/93 13:57:28

==

TEST DESCRIPTION

```
Data set........... 67b.inp
Data set title..... Slug Withdrawal Test Well S - 67
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/18/93

Knowns and Constants:
   No. of data points.................. 158
   Radius of well casing............... 0.167
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 10
   Static height of water in well...... 18.17
   Log(Re/Rw).......................... 2.098
   A, B, C.............................  2.262,  0.363,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
        Estimate
  K  = 5.28556E-003
  y0 = 8.07983E-001
```

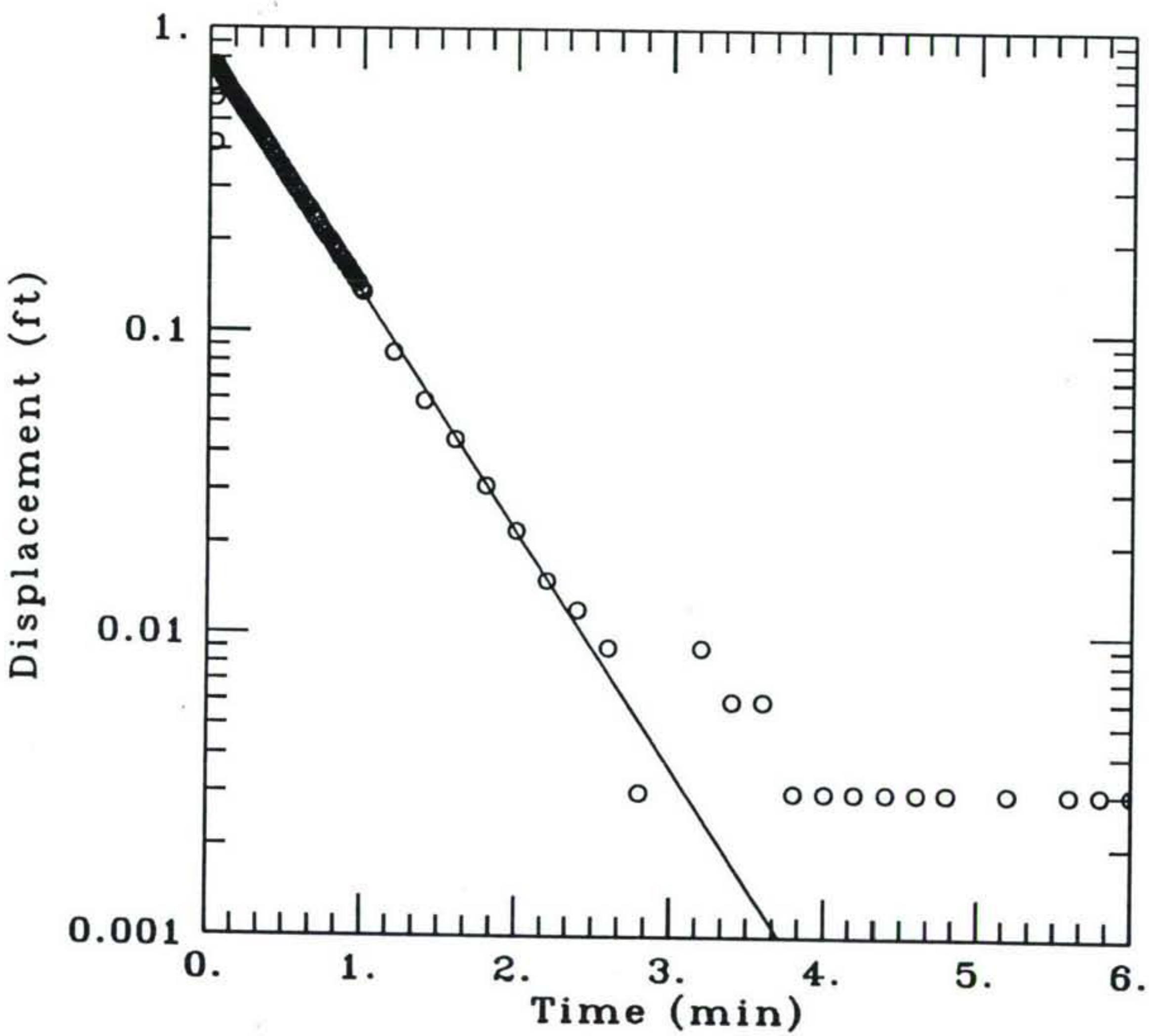
EBASCO

Project No.: TEAD-S

Client: USAEC

Location: SWMU 25

Slug Withdrawal Test Well S - 67



DATA SET:
67b.inp
03/31/93

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/18/93

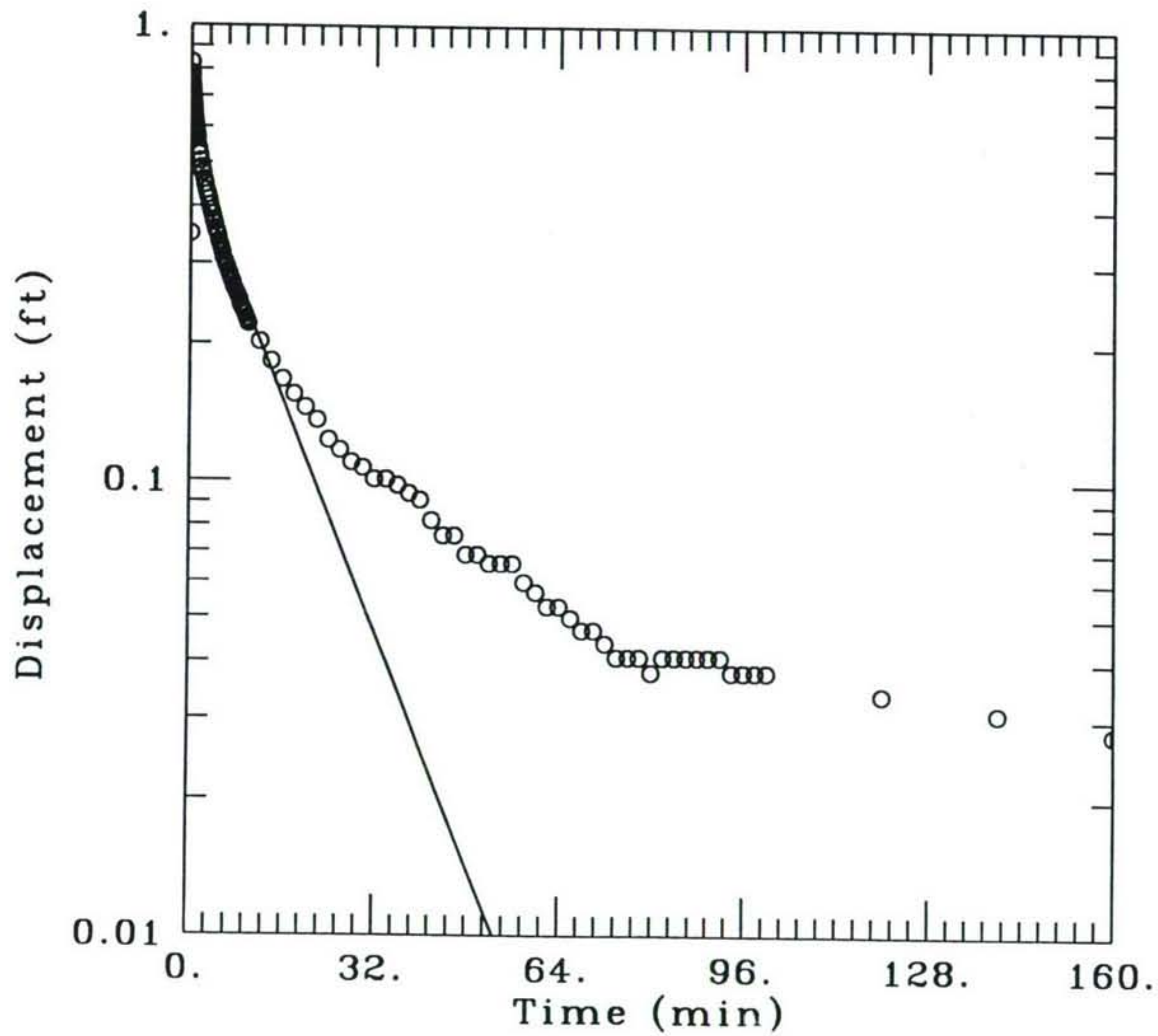
ESTIMATED PARAMETERS:
K = 0.005286 ft/min
y0 = 0.808 ft

TEST DATA:
H0 = 0.757 ft
rc = 0.167 ft
rw = 0.417 ft
L = 10. ft
b = 200. ft
H = 18.17 ft

```
                    A Q T E S O L V   R E S U L T S

                             Version 1.10

01/04/94                                                        14:54:42

================================================================================
                           TEST DESCRIPTION

Data set........... 68b.inp
Data set title..... Slug Withdrawal Test Well S - 68
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/17/93

Knowns and Constants:
   No. of data points.................. 267
   Radius of well casing............... 0.167
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 10
   Static height of water in well...... 23.65
   Log(Re/Rw).......................... 2.186
   A, B, C.............................  2.262,  0.363,  0.000

================================================================================
                           ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)


================================================================================
                   RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

           Estimate
   K  =   2.2399E-004
   y0 =   4.8912E-001
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 68



DATA SET:
68b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/17/93

ESTIMATED PARAMETERS:
K = 0.000224 ft/min
y0 = 0.4891 ft

TEST DATA:
H0 = 0.826 ft
rc = 0.167 ft
rw = 0.417 ft
L = 10. ft
b = 200. ft
H = 23.65 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 14:59:30

==

TEST DESCRIPTION

```
Data set........... 69b.inp
Data set title..... Slug Withdrawal Test Well S - 69
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/16/93

Knowns and Constants:
   No. of data points................. 224
   Radius of well casing.............. 0.15
   Radius of well..................... 0.417
   Aquifer saturated thickness......... 100
   Well screen length................. 10
   Static height of water in well...... 22.55
   Log(Re/Rw)......................... 2.227
   A, B, C............................ 2.262,  0.363,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

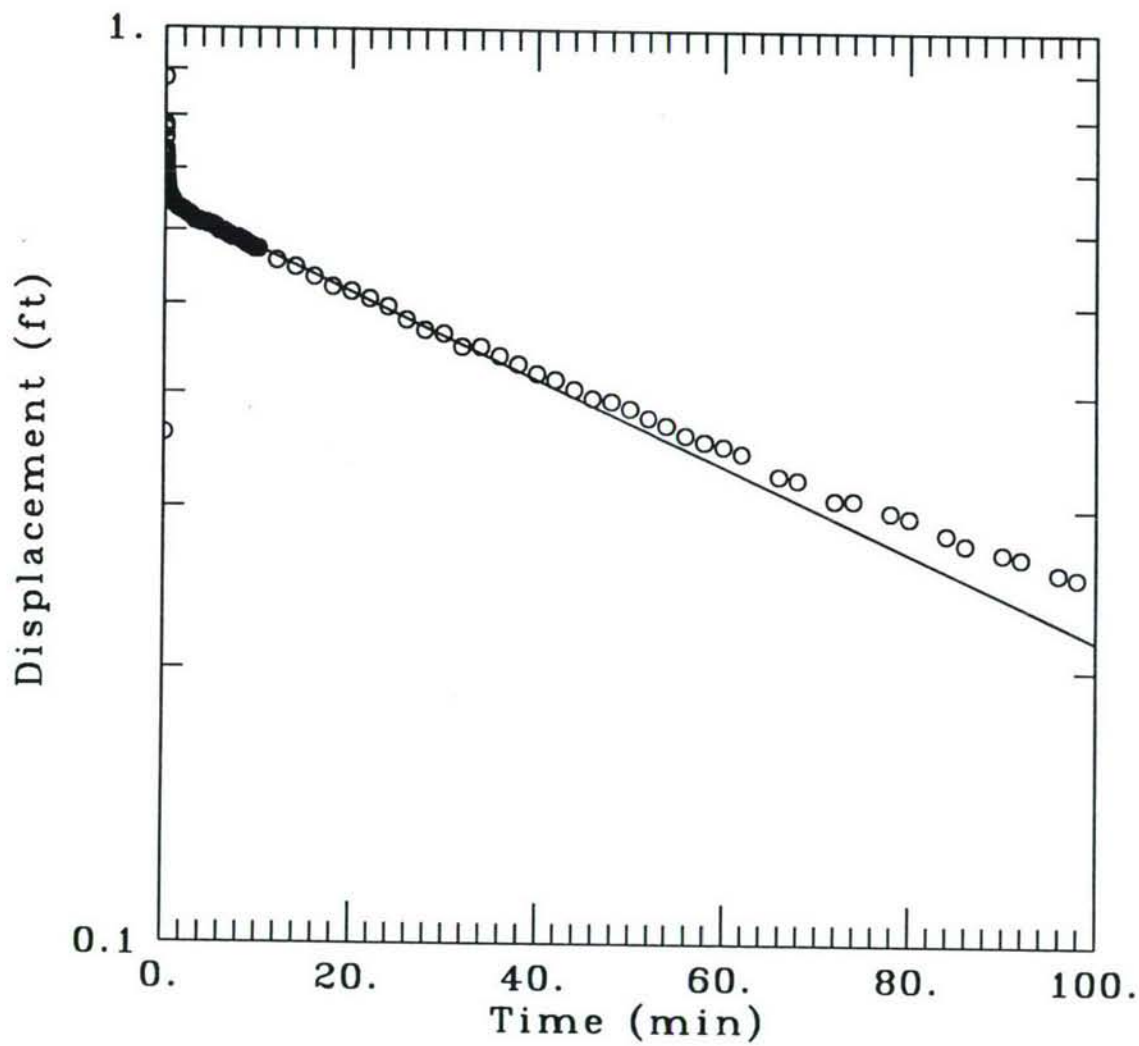
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
         Estimate
  K  =   2.7308E-005
  y0 =   6.4127E-001
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 69



DATA SET:
69b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/16/93

ESTIMATED PARAMETERS:
K = 2.7308E-05 ft/min
y0 = 0.6413 ft

TEST DATA:
H0 = 0.88 ft
rc = 0.15 ft
rw = 0.417 ft
L = 10. ft
b = 100. ft
H = 22.55 ft

A Q T E S O L V ' R E S U L T S

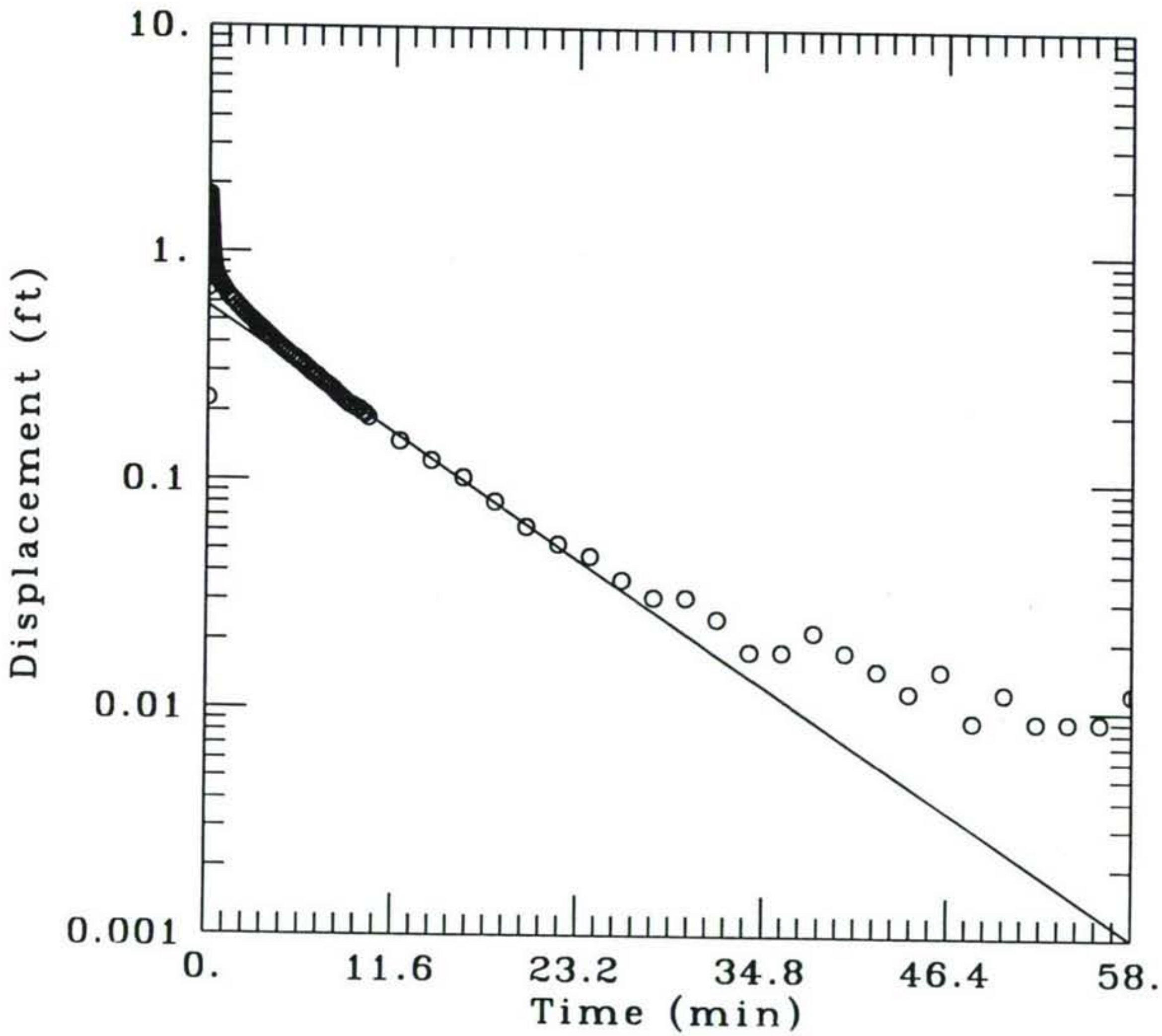
Version 1.10

01/04/94 15:03:14

```
================================================================================
                              TEST DESCRIPTION

Data set........... 70b.inp
Data set title..... Slug Withdrawal Test Well S - 70
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/17/93

Knowns and Constants:
   No. of data points.................. 208
   Radius of well casing............... 0.268
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 6.35
   Static height of water in well...... 6.35
   Log(Re/Rw).......................... 1.524
   A, B, C.............................  2.026,  0.303,  0.000

================================================================================
                              ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)


================================================================================
                        RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

          Estimate
  K  =   9.4436E-004
  y0 =   5.7544E-001
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 70



DATA SET:
70b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/17/93

ESTIMATED PARAMETERS:
K = 0.0009444 ft/min
y0 = 0.5754 ft

TEST DATA:
H0 = 1.772 ft
rc = 0.268 ft
rw = 0.417 ft
L = 6.35 ft
b = 200. ft
H = 6.35 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 15:07:00

==

TEST DESCRIPTION

```
Data set........... 71b.inp
Data set title..... Slug Withdrawal Test Well S - 71
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/11/93

Knowns and Constants:
   No. of data points.................. 264
   Radius of well casing............... 0.161
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 10
   Static height of water in well...... 28.02
   Log(Re/Rw).......................... 2.239
   A, B, C.............................  2.262,  0.363,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

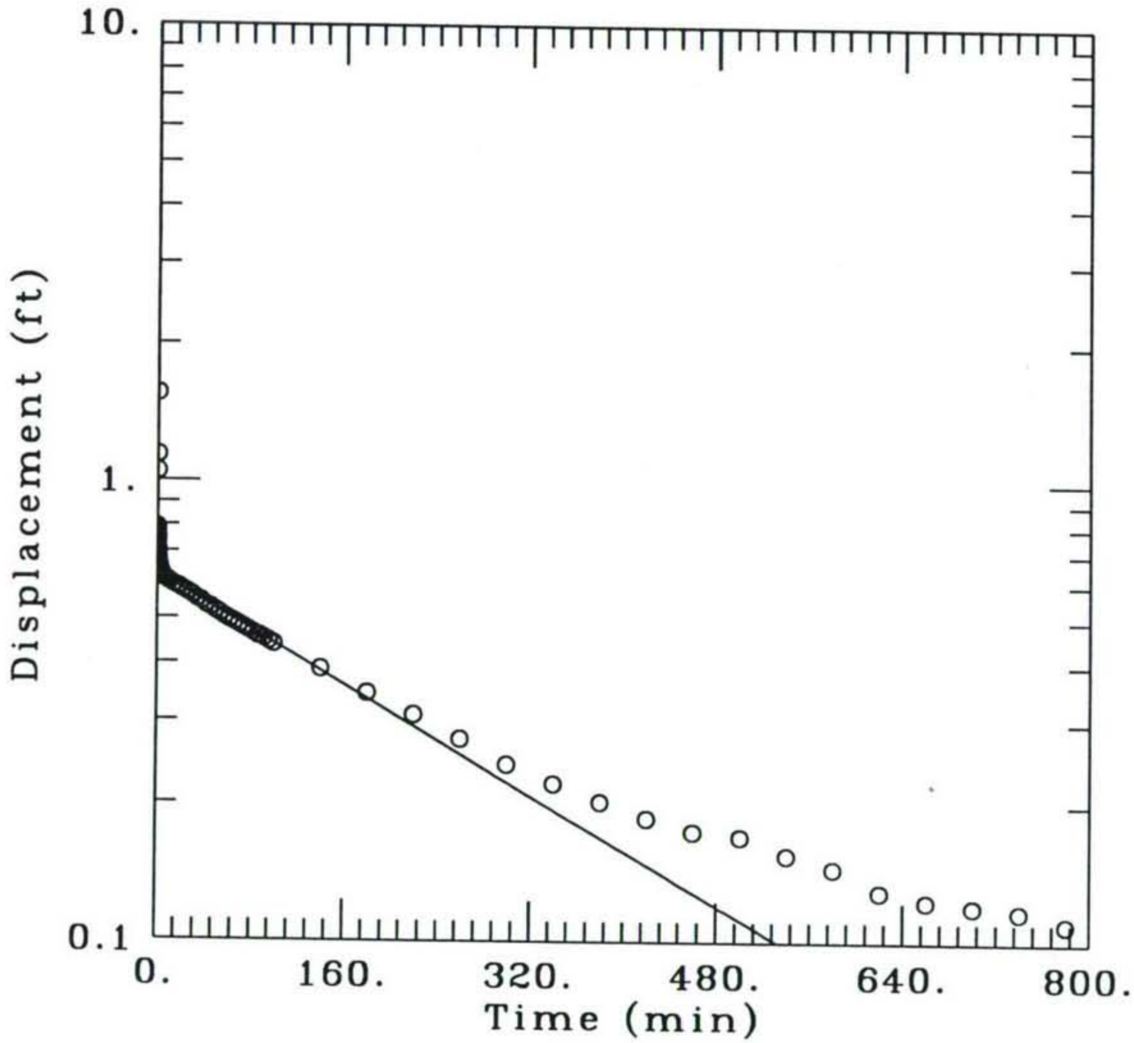
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
          Estimate
   K  =   9.9793E-006
   y0 =   6.2373E-001
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 71



DATA SET:
71b.inp
01/04/94

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
2/11/93

ESTIMATED PARAMETERS:
K = 9.9793E-06 ft/min
y0 = 0.6237 ft

TEST DATA:
H0 = 0.788 ft
rc = 0.161 ft
rw = 0.417 ft
L = 10. ft
b = 200. ft
H = 28.02 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/04/94 15:30:52

==

TEST DESCRIPTION

Data set........... 93b.inp
Data set title..... Slug Withdrawal Test Well S - 93
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 1
Test date.......... 2/8/93

Knowns and Constants:
No. of data points.................. 264
Radius of well casing............... 0.167
Radius of well...................... 0.308
Aquifer saturated thickness......... 200
Well screen length.................. 15
Static height of water in well...... 87.48
Log(Re/Rw).......................... 3.163
A, B, C............................. 3.034, 0.488, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

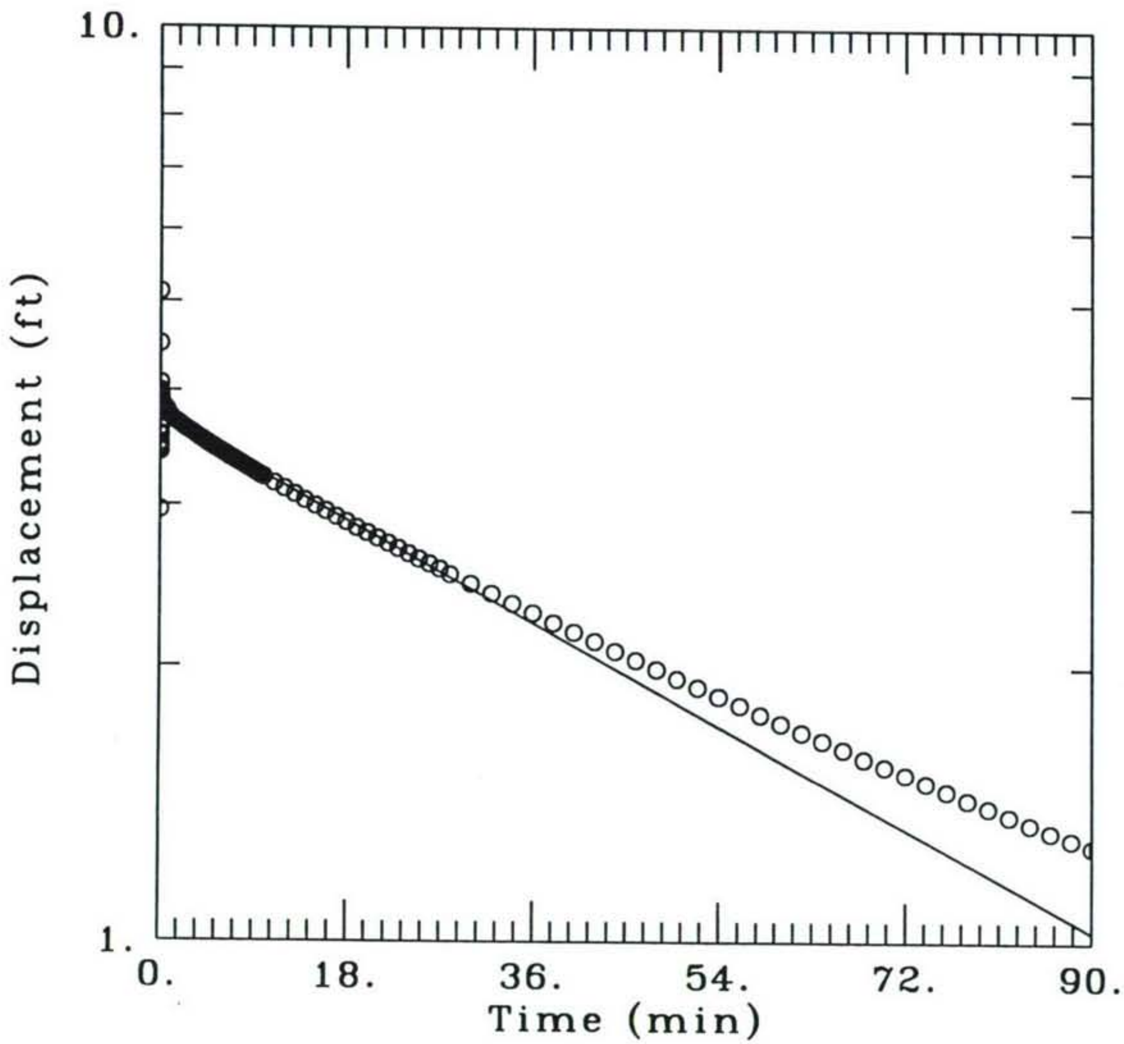
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	4.2300E-005
y0 =	3.7455E+000

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 1

Slug Withdrawal Test Well S - 93



DATA SET:
93b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/8/93

ESTIMATED PARAMETERS:
K = 4.2301E-05 ft/min
y0 = 3.746 ft

TEST DATA:
H0 = 5.12 ft
rc = 0.167 ft
rw = 0.308 ft
L = 15. ft
b = 200. ft
H = 87.48 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/05/94 10:09:20

==

TEST DESCRIPTION

```
Data set........... 97b.inp
Data set title..... Slug Withdrawal Test Well S - 97
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/3/93

Knowns and Constants:
   No. of data points.................. 233
   Radius of well casing............... 0.167
   Radius of well...................... 0.308
   Aquifer saturated thickness......... 200
   Well screen length.................. 10
   Static height of water in well...... 13.88
   Log(Re/Rw).......................... 2.261
   A, B, C.............................  2.521,  0.410,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

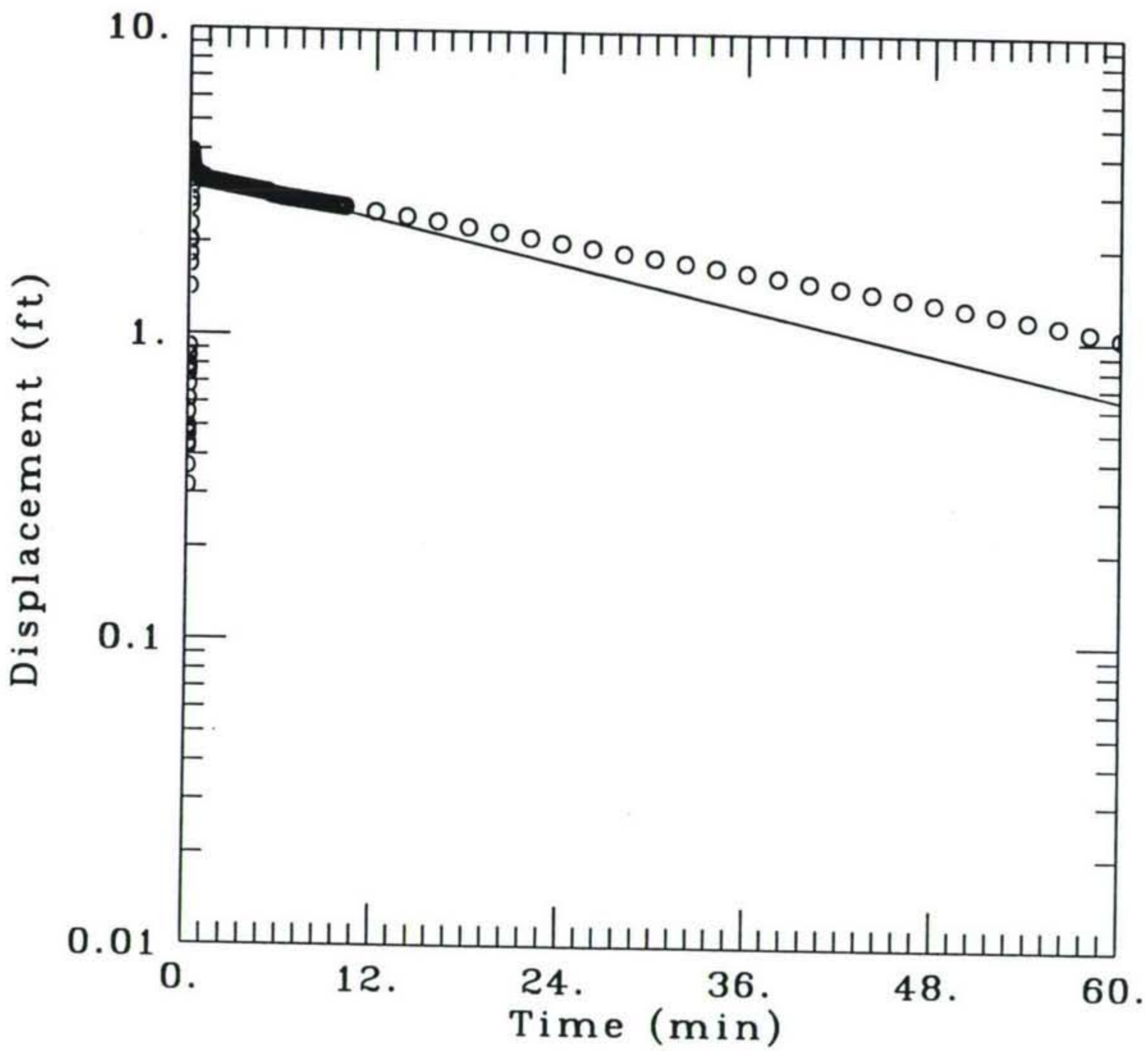
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
          Estimate
   K  =   8.6025E-005
   y0 =   3.3283E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 97



DATA SET:
97b.inp
01/05/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/3/93

ESTIMATED PARAMETERS:
K = 8.6025E-05 ft/min
y0 = 3.328 ft

TEST DATA:
H0 = 0.846 ft
rc = 0.167 ft
rw = 0.308 ft
L = 10. ft
b = 200. ft
H = 13.88 ft

A Q T E S O L V   R E S U L T S

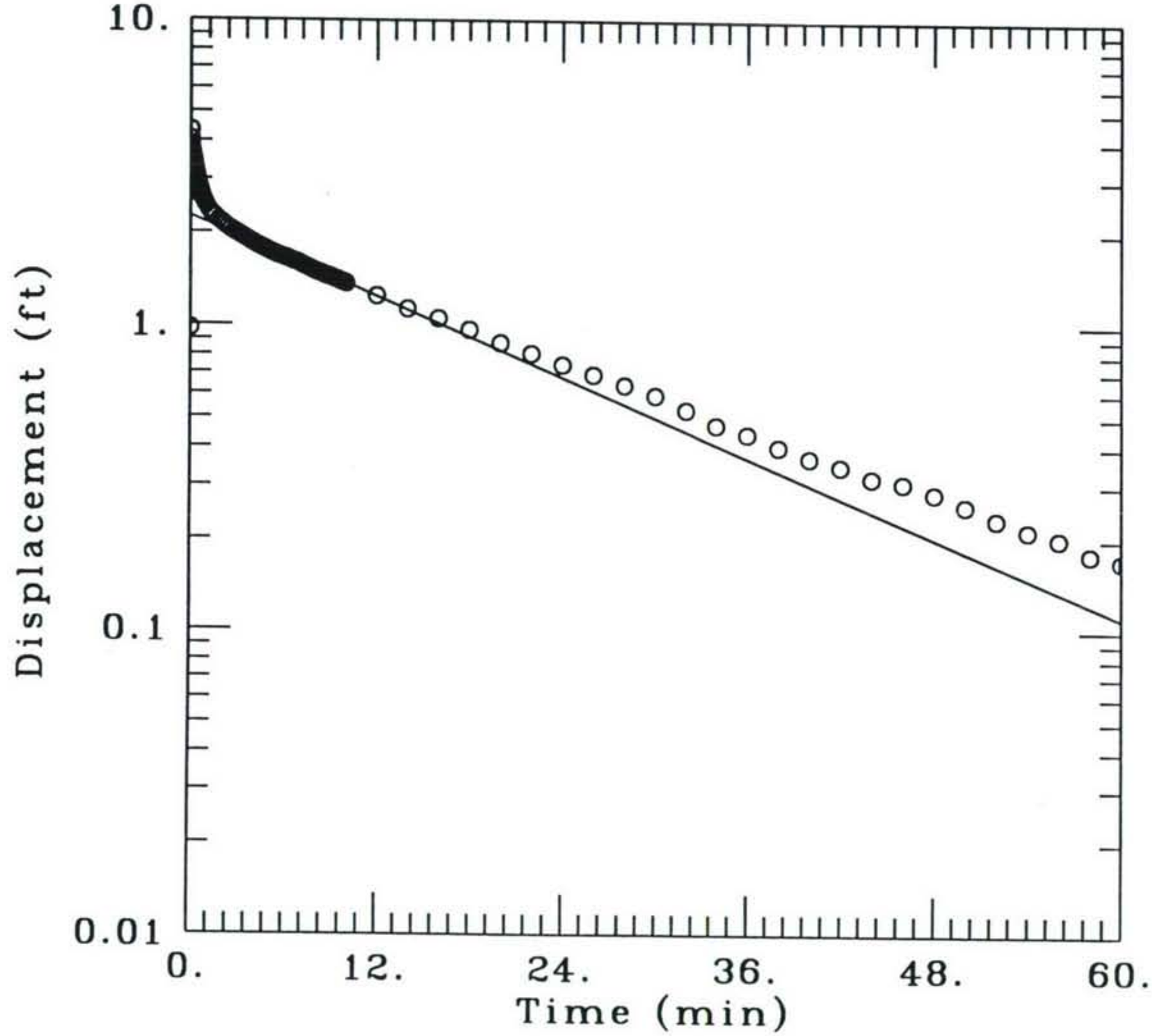
Version 1.10

01/04/94 16:18:48

```
================================================================================
                              TEST DESCRIPTION

Data set........... 98b.inp
Data set title..... Slug Withdrawal Test Well S - 98
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/13/93

Knowns and Constants:
   No. of data points.................. 230
   Radius of well casing............... 0.167
   Radius of well...................... 0.313
   Aquifer saturated thickness......... 200
   Well screen length.................. 10.5
   Static height of water in well...... 11.35
   Log(Re/Rw).......................... 2.189
   A, B, C............................. 2.555,  0.416,  0.000

================================================================================
                              ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)


================================================================================
                      RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

          Estimate
   K  =   1.4642E-004
   y0 =   2.2629E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S - 98



DATA SET:
98b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/13/93

ESTIMATED PARAMETERS:
K = 0.0001464 ft/min
y0 = 2.263 ft

TEST DATA:
H0 = 4.326 ft
rc = 0.167 ft
rw = 0.313 ft
L = 10.5 ft
b = 200. ft
H = 11.35 ft

A Q T E S O L V   R E S U L T S

Version 1.10

01/05/94 10:23:02

==

TEST DESCRIPTION

```
Data set........... 99b.inp
Data set title..... Slug Withdrawal Test Well S - 99
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/6/93

Knowns and Constants:
   No. of data points.................. 254
   Radius of well casing............... 0.219
   Radius of well...................... 0.308
   Aquifer saturated thickness......... 200
   Well screen length.................. 8.44
   Static height of water in well...... 8.44
   Log(Re/Rw).......................... 1.99
   A, B, C.............................  2.364,  0.383,  0.000
```

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

```
          Estimate
  K  =   2.1034E-004
  y0 =   2.0888E+000
```

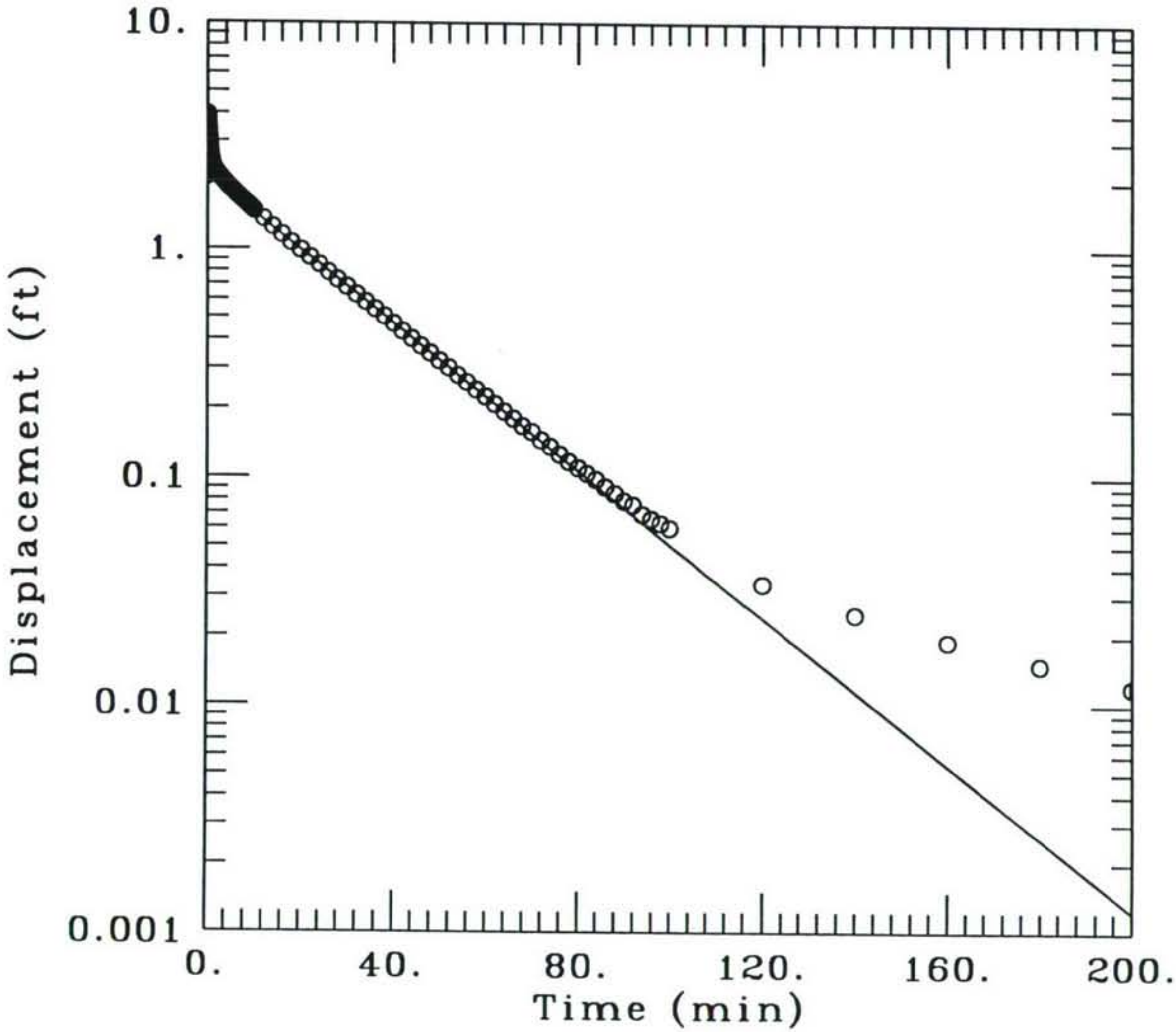
EBASCO

Client: USAEC

Project No.: TEAD-S

Location: SWMU 25

Slug Withdrawal Test Well S - 99



DATA SET:
99b.inp
01/05/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/6/93

ESTIMATED PARAMETERS:
K = 0.0002103 ft/min
y0 = 2.089 ft

TEST DATA:
H0 = 3.918 ft
rc = 0.219 ft
rw = 0.308 ft
L = 8.44 ft
b = 200. ft
H = 8.44 ft

A Q T E S O L V   R E S U L T S

Version 1.10

04/01/93 11:58:51

==

TEST DESCRIPTION

Data set........... 100b.inp
Data set title..... Slug Withdrawal Test Well S -100
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/6/93

Knowns and Constants:
No. of data points.................. 238
Radius of well casing............... 0.167
Radius of well...................... 0.417
Aquifer saturated thickness......... 200
Well screen length.................. 15
Static height of water in well...... 23.79
Log(Re/Rw).......................... 2.4
A, B, C............................. 2.632, 0.428, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

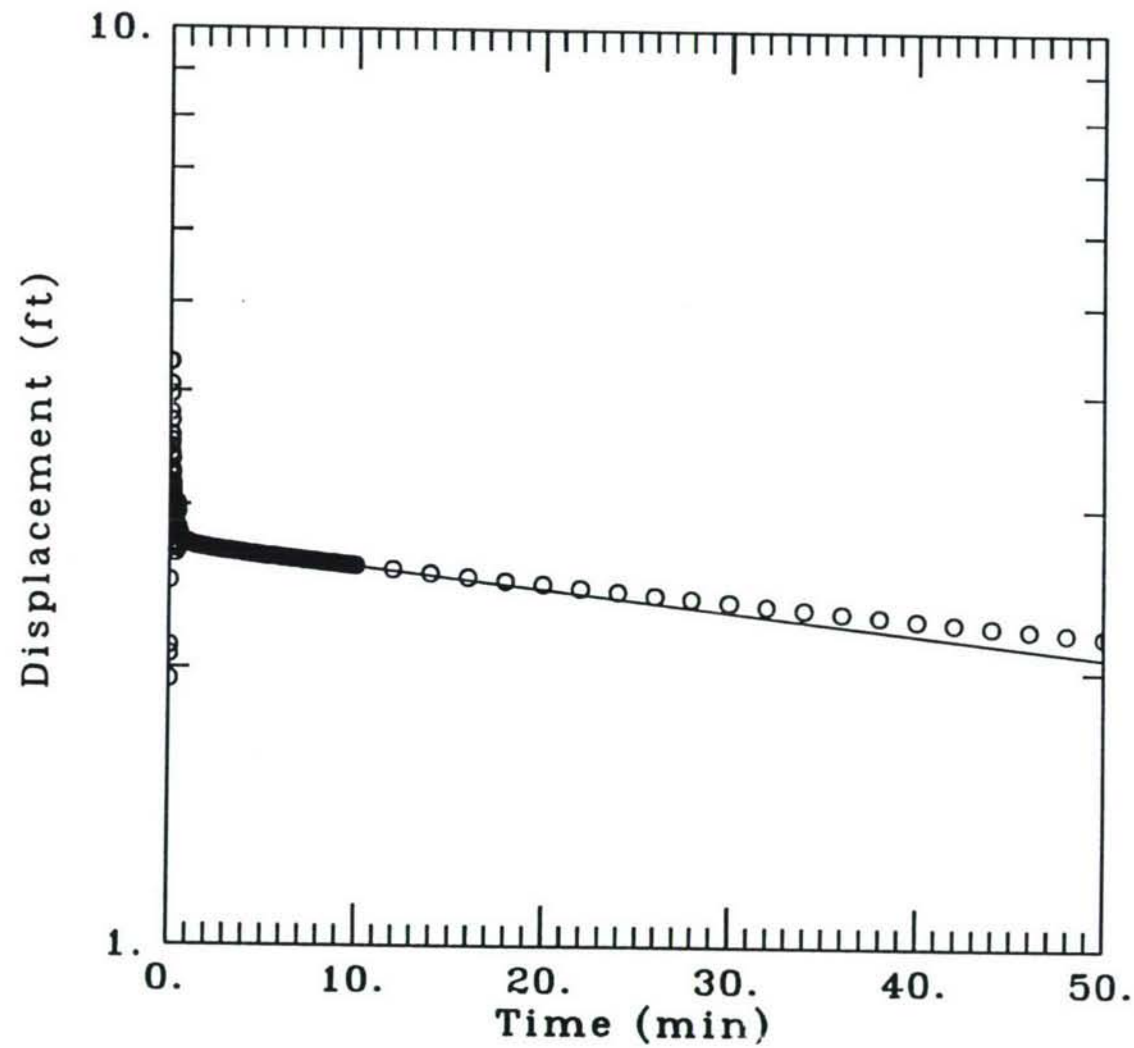
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

Estimate
K = 1.21790E-005
y0 = 2.72270E+000

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S -100



DATA SET:
100b.inp
04/01/93

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
2/6/93

ESTIMATED PARAMETERS:
K = 1.2179E-05 ft/min
y0 = 2.723 ft

TEST DATA:
H0 = 4.302 ft
rc = 0.167 ft
rw = 0.417 ft
L = 15. ft
b = 200. ft
H = 23.79 ft

A Q T E S O L V   R E S U L T S

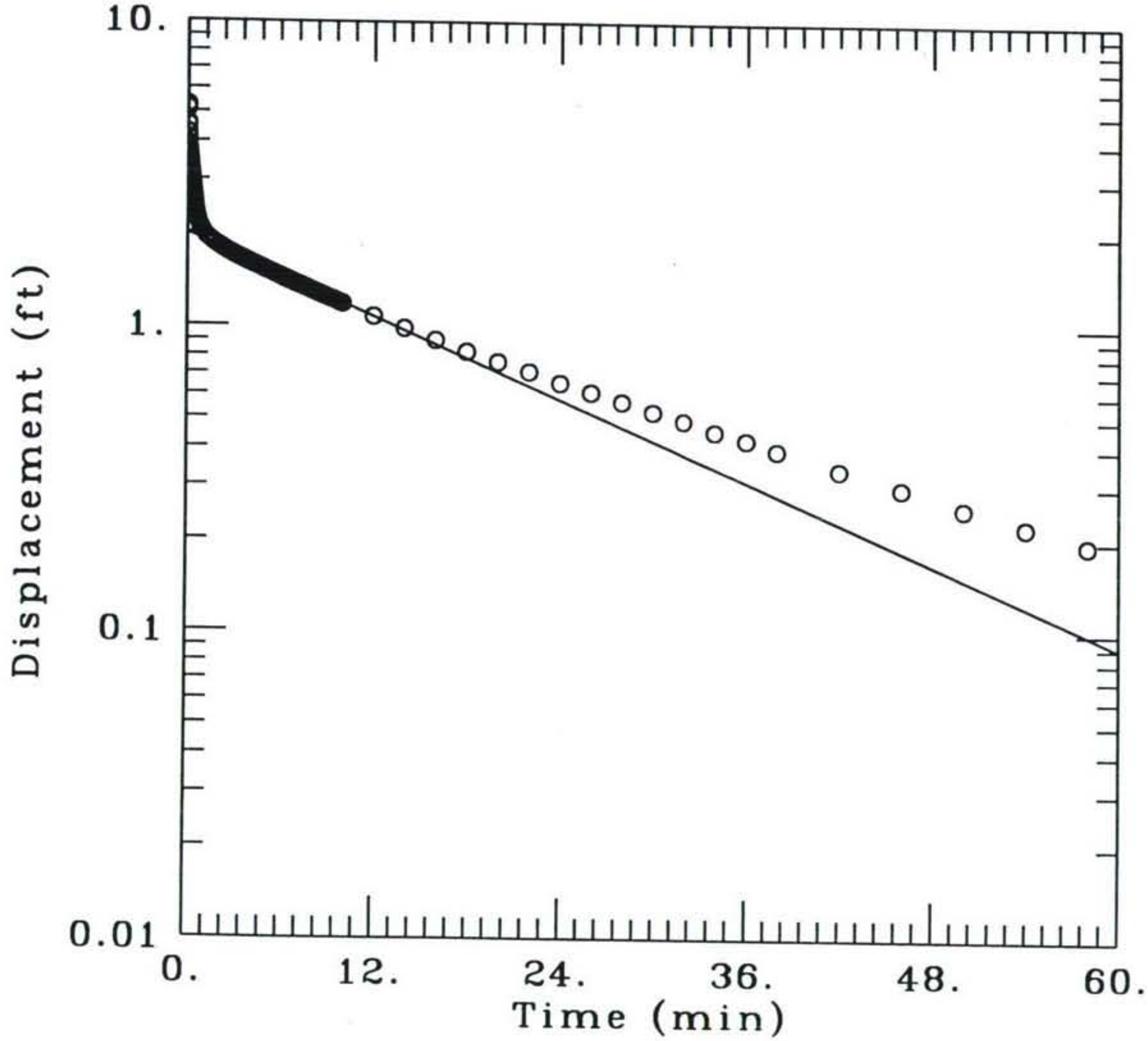
Version 1.10

01/04/94   16:35:22

```
================================================================================
                              TEST DESCRIPTION

Data set........... 101b.inp
Data set title..... Slug Withdrawal Test Well S -101
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/5/93

Knowns and Constants:
   No. of data points.................. 233
   Radius of well casing............... 0.167
   Radius of well...................... 0.308
   Aquifer saturated thickness......... 200
   Well screen length.................. 10.5
   Static height of water in well...... 10.95
   Log(Re/Rw).......................... 2.187
   A, B, C.............................  2.572,  0.419,  0.000

================================================================================
                              ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)


================================================================================
                      RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

           Estimate
  K  =    1.4988E-004
  y0 =    1.9916E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S -101



DATA SET:
101b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/5/93

ESTIMATED PARAMETERS:
K = 0.0001499 ft/min
y0 = 1.992 ft

TEST DATA:
H0 = 5.244 ft
rc = 0.167 ft
rw = 0.308 ft
L = 10.5 ft
b = 200. ft
H = 10.95 ft

A Q T E S O L V   R E S U L T S

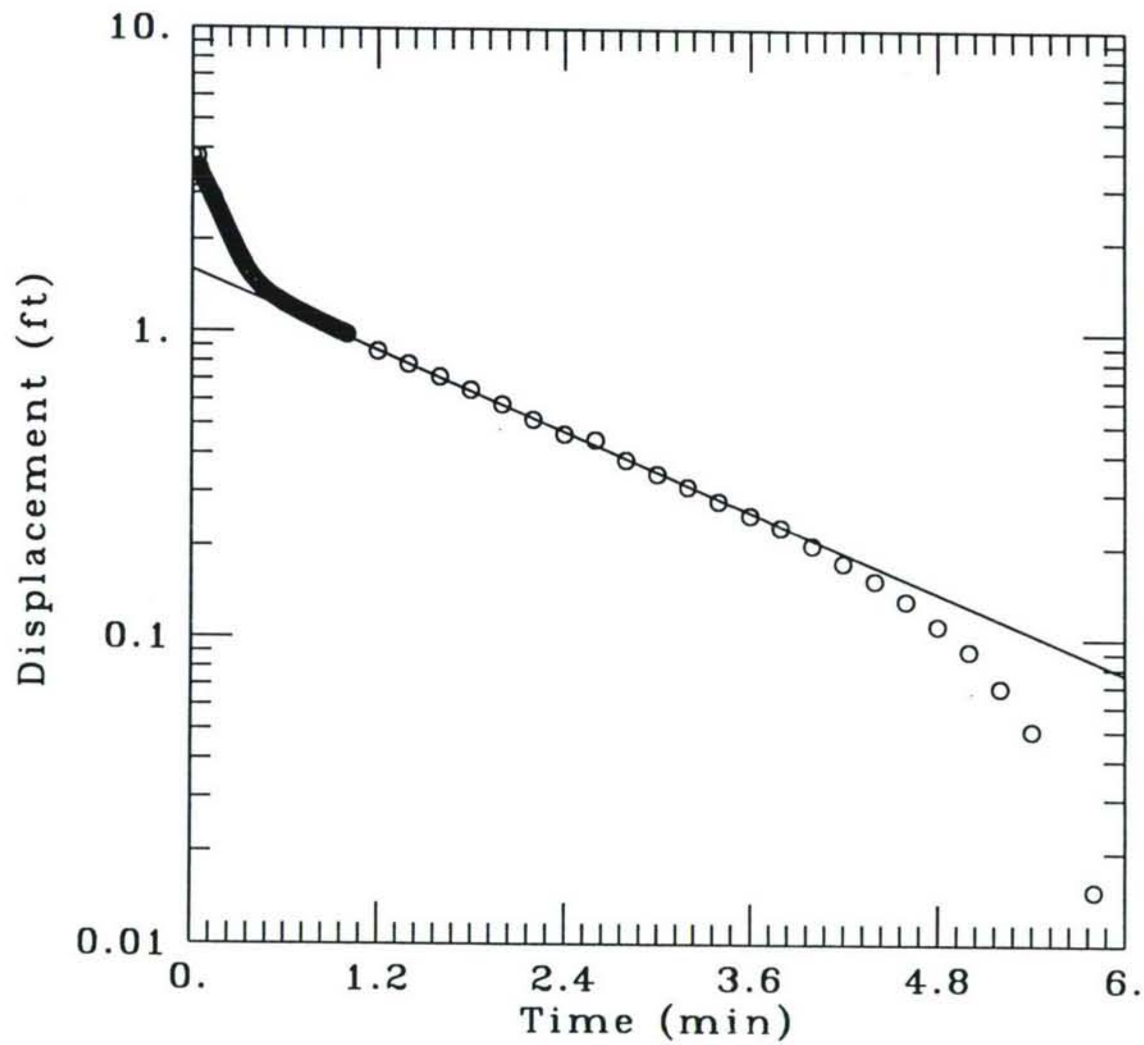
Version 1.10

01/04/94 16:38:29

```
================================================================================
                              TEST DESCRIPTION

Data set........... 102b.inp
Data set title..... Slug Withdrawal Test Well S -102
Company............ EBASCO
Project............ TEAD-S
Client............. USAEC
Location........... SWMU 25
Test date.......... 2/6/93

Knowns and Constants:
   No. of data points.................. 157
   Radius of well casing............... 0.268
   Radius of well...................... 0.417
   Aquifer saturated thickness......... 200
   Well screen length.................. 9.56
   Static height of water in well...... 9.56
   Log(Re/Rw).......................... 1.846
   A, B, C.............................  2.232,  0.356,  0.000

================================================================================
                              ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

================================================================================
                        RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

           Estimate
  K  =    3.5111E-003
  y0 =    1.5991E+000
```

EBASCO	Client: USAEC
Project No.: TEAD-S	Location: SWMU 25

Slug Withdrawal Test Well S -102



DATA SET:
102b.inp
01/04/94

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
2/6/93

ESTIMATED PARAMETERS:
K = 0.003511 ft/min
y0 = 1.599 ft

TEST DATA:
H0 = 3.763 ft
rc = 0.268 ft
rw = 0.417 ft
L = 9.56 ft
b = 200. ft
H = 9.56 ft

APPENDIX C

MONITORING WELL SURVEY DATA

PROJECT REPORT

TOOLE ARMY DEPOT
SOUTH AREA
TOOELE COUNTY, UTAH

USATHAMA SURVEY
1993

FOR
ENSEARCH INCORPORATED
ENVIRONMENTAL DIVISION
143 UNION BOULEVARD, SUITE 1060
LAKEWOOD, CO 80228-1824

PREPARED BY
AAA ENGINEERING & DRAFTING, INC.
1865 SOUTH MAIN STREET, SUITE 12
SALT LAKE CITY, UT 84115

FEBRUARY 1994

FEBRUARY 14, 1994

AAA ENGINEERING & DRAFTING, INC.

P.O. BOX 58171/1865 SOUTH MAIN/SUITE 12/SALT LAKE CITY, UTAH 84158-0171 (801) 487-9908 FAX (801) 466-4560

AAA ENGINEERING & DRAFTING, INC.

COPY

PROJECT REPORT

TOOLE ARMY DEPOT
SOUTH AREA
TOOELE COUNTY, UTAH

USATHAMA SURVEY
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SALT LAKE CITY, UT 84115

FEBRUARY 1994

...ED LAND SURVEYOR
#5685
R. LYNN
PETERSON
STATE OF UTAH

R. Lynn Peterson

FEBRUARY 14, 1994

TABLE OF CONTENTS

I. INTRODUCTION

AAA Engineering & Drafting, Inc. (AAA) is a sub-contractor to Ebasco Services, Inc. to provide Surveying services for Monitoring Wells at various Solid Waste Management Units (SWMU) at Tooele Army Depot, South Area, Utah. The survey was completed using conventional survey methods.

II. DESCRIPTION OF WORK

AAA's task was to provide horizontal state plane (N.A.D. 27-Sea Level), and UTM (N.A.D. 27) coordinates and vertical elevations NGVD 1929 (based on NGS adjusted elevations-1974) for:

A. Two (2) monitoring wells at SWMU 1, five (5) monitoring wells near SWMU 5 and 9 and eight (8) monitoring wells at SWMU 25 at Tooele South Depot Area.

B. Preparation of report.

III. PROCEDURES, EQUIPMENT AND PERSONNEL USED ON PROJECT

A. The horizontal surveying for Monitoring Wells was completed in accordance with Geodetic Control Network accuracy for Third Order Class II (1:5000) Surveying. Horizontal positions for all monitoring wells was accomplished by occupying existing monitoring well S-50-90 and sighting monitoring well no. S-43-90, occupying monitoring well no S-71-90 and sighting monitoring well no. S-70-90 then turning double angled sideshots to the various wells.

B. All vertical control surveying was accomplished using differential leveling procedures from known elevations at top of metal well casings. All vertical elevations are within the required accuracy requirement of ± 0.01 feet.

C. The horizontal control surveying was completed with a Wild T16 instrument with a top mounted Beetle 2000 EDM. Longer distances were measured with two sets of triple glass prisms. All measurements were averaged from 3 separate readings and all angle measurements were accomplished through double observations. The vertical differential loops were accomplished with a SOKKISHA B2-C automatic level.

D. PERSONNEL

AAA personnel assigned to this project were:

Lynn Peterson, Project Manager and Licensed Surveyor.

Craig Anderson, Instrument Man.

Chris Andersen, Rodman.

These personnel complied with the Ebasco Health and Safety Program.

IV. KNOWN COORDINATES AND VERTICAL ELEVATIONS:

Vertical elevations are National Geodetic Datum 1929 (ADJUSTED 1974).

A. KNOWN HORIZONTAL CONTROL POSITIONS

	State Plane 1927 N.A.D. (Feet)	
Well No.	Northing	Easting
S-43-90	716,777.2	1,771,531.9
S-50-90	713,629.2	1,770,871.0
S-70-90	703,629.0	1,767,581.8
S-71-90	703,648.6	1,769,902.9

B. KNOWN VERTICAL CONTROL POSITIONS

SWMU MON 25 NE	5078.07
S-50-90 (T.O.C.)	5152.87
S-68-90 (T.O.C.)	5058.99
S-70-90 (T.O.C.)	5060.75
S-71-90 (T.O.C.)	5056.05

(T.O.C.) Top of Metal Casing)

C. LEVEL CIRCUITS

	CLOSURE
Well S-50-90 to Well S-50-90 (S-108-93)	0.000'
Well S-50-90 to Well S-50-90 (S-109-93 & S-110-93)	0.005'
Well S-108-93 to Well S-108-93 (TBM TS94-1)	0.005'
TBM TS94-1 to TBM TS94-1 S-111-93 & S-112-93)	0.005'
SWMU Mon 25ME to SWMU Mon 25NE (S-98-92 & S-100-92)	0.08 (Adjusted over 16 turns)
Well S-71-90 to Well S-71-90 (S-96-92)	0.010'
Well S-71-90 to Well S-71-90 (S-93-92)	0.010'
Well S-68-90 to Well S-68-90 (S-97-92, S-99-92 & 5-95-92)	0.040' (Adjusted over 12 turns)
Well S-99-92 to Well S-99-92 (S-101-92 & S-102-92)	0.010'

AAA used Holguin Software to compute and balance Traverse Closures. Also a P.C. using National Geodetic Survey programs (Corps Con) to calculate conversion from SPC to Geodetic Positions and then to UTM coordinates was used.

V. FIELD SURVEY NOTES

5-10-93
T L.PETERSON
CH. C ANDERSON

TOOELE SOUTH DEPOT

SCALE FACTOR
(.99968422)

5-10-93

⊼ L. PETERSON

CK C ANDERSON

65°

WINDY

TOOELE SOUTH DEPOT

EBASCO

SCALE FACTOR

(.99968422)

STA	+	HI	-	ELEV.
				5078.07
	4.615	5082.685		
			4.360 / 4.355	5078.320
	10.165	5088.490		
			5.200 / 5.195	5083.290
	6.075	5089.365		
			8.405 / 8.400	5080.960
	1.550	5082.510		
			17.255 / 17.250	5065.255
	0.950	5066.205		
			13.300 / 13.295	5052.905
	1.290	5054.195		
			6.390 / 6.385	5047.805
	4.350	5052.155		
			5.150 / 5.145	5047.005
	4.655	5051.660		
			5.345 / 5.34	5046.315
			2.660 / 2.655	5049.00
			2.900 / 2.895	504876
			5.410 / 5.405	5046.25
	5.690	5051.940		
			3.070 / 3.065	5048.870

ENMU MON. 25 NE (ADJUSTED) 1976

WELL NO GROUND
S-98-92 TOP M. [illegible]
TOP PVC [illegible]

STA	+	HI	-	ELEV ADJUSTED
	7.935	5056.805		
			0.955 ~~0.950~~	5055.850
	11.695	5067.495		
			4.455 ~~4.450~~	5063.040
	16.255	5079.295		
			4.550 ~~4.545~~	5074.745
	7.425	5082.170		
			6.780 ~~6.775~~	5075.390
	2.250	5077.640		
			0.755 ~~0.750~~	5076.885
			0.595 ~~0.590~~	5077.045
			2.965 ~~2.960~~	5074.675
			7.655 ~~7.650~~	5069.985
	7.475	5077.460		
			2.760 ~~2.755~~	5074.700
	7.190	5081.89		
			3.815 ~~3.810~~	5078.075
CLOSURE	99.515		99.430	

ADD .005 TO - COL.

WELL NO. TOP PVC. CASING
5-100-92 '' METAL ''
GROUND ''

SWMU NE 25

5-11-93

X L. PETERSON

CH. C. ANDERSON

70° SUNNY

BREEZY

TOOELE SOUTH DEPOT AREA

EBASCO

⊼@ S-71-90 WELL 11
SIGHT 30|29 10
31|35

∢S RT 163-30-45
327-00-50 163-30-25
V∢ 89-19-50
EDM 1598.78
1598.79
1598.79
NO 1598.68 S.L.D. (1598.18)
TO S-96-92 14

⊼@ S-71-90- 11
SIGHT SECT COR 10
∢'S LT 137-04-50
274-09-40 137-04-50
V∢ 89-28-50
EDM 2121.87
2121.97 2121.95
2122.02
NO 2121.87 S.L.D. (2121.18)
TO S-93-92 15

⊼@ S-71-90 SIGHT
SECTION COR
∢'S RT 70-03-40 70-03-30
140-07-00
V∢ 89-20-00
EDM 3184.47
3184.47 3184.48
3184.50
NO 3184.26 S.L.D. (3183.25)
TO "NEBO" 12

⊼@ S-71-90 SIGHT 11
SECTION COR 11
∢'S RT 62-27-00 62-27-20
124-54-40
V∢ 89-22-00
EDM 3284.60
3284.72 3284.68
3284.71
HD 3284.48 S.L.D. (3283.44)
TO
WK PT ~~CRAIG-1~~
S-97-92 16

STA	+	HI	-	ELEV	
					NGVD 1929 (1974 ADJUSTED)
				5056.05	TOP METAL CASING 5-71-90
	3.475	5059.525			
			2.585	5056.940	
	6.970	5063.910			
			1.340	5062.570	
	10.335	5072.905			
			1.395	5071.51	WELL S-96-92 TOP PVC CASING
			1.235	5071.67	TOP METAL CASING
			3.650	5069.255	GROUND
			9.555	5063.350	
	1.900	5065.250			
			7.525	5057.725	
	2.750	5060.475			
			4.410	5056.065	TBM TOP METAL CASING 5-71-90
	25.430		25.415		

STA	+	HI	-	ELEV	
				5056.05	TBM 5-71-90 TOP METAL CASING
	2.375	5058.425			
			1.375	5057.050	
	8.760	5065.810			
			2.575	5063.235	
	6.560	5069.795			
			3.735	5066.06	
	6.965	5073.025			
			0.050	5072.975	WELL NO TBM TOP OF METAL CAP NORTH SIDE
				5072.745	5-93-92 TOP METAL CASING
				5072.955	TOP PVC CASING.
			2.880	5070.145	GROUND
			7.090	5065.935	
	4.280	5070.215			
			7.425	5062.790	
	3.125	5065.915			
			9.025	5056.890	
	0.980	5057.870			
			1.805	5056.065	5-71-90 TBM TOP CASING
	33.045		33.030		
				5072.975	TBM TOP CAP 5-93-92
	2.595	5075.570			
			2.825	5072.745	TOP METAL CASING
			2.615	5072.955	TOP PVC CASING

⊼@ NEBO 12 SIGHT 5-71-90 11
4'S LT 172-04-50   172-05-00
344-10-00
V∢ 90-37-10
EDM 2922.96
2923.00 } 2922.93
2922.83
HD 2922.76 S.L.D. (2921.84)
TO 5-101-92 WEST WELL
17

⊼@ NEBO SIGHT 5-71-90
12   11
K'S LT 167-53-20
335-46-50   167-53-25
V∢ 90-51-10
EDM 2584.64
2584.70 } 2584.68
2584.71
HD 2584.40 S.L.D. (2583.58)
TO 5-102-92 EAST WELL
18

⊼@ NEBO 12 SIGHT 5-71-90 11
4'S LT 136-58-45
273-57-20   136-58-40
V∢ 90-14-50
EDM 3370.13
3370.13 } 3370.14
3370.15
HD 3370.11 S.L.D. (3369.05)
TO 5-100-92 NORTH WELL
19

⊼@ NEBO SIGHT 5-71-90
K'S

5-12-93

A. L. PETERSON

C. C. ANDERSON

SUNNY 80°

TOOELE SOUTH DEPOT AREA.

EBASCO

12 11
⊼@ NEBO SIGHT 5-11-90
∡'S LT 164-49-18
359-38-50 164-49-25
V∡ 90-53-00
EDM 5727.97
5727.81 } 5727.93
5728.00
HD 5727.80 S.L.D. (5725.99)
TO 5-98-92 20

12 11
⊼@ NEBO SIGHT 5-11-90
∡S LT 184-39-40
09-19-05 184-39-33
V∡ 91-08-30
EDM 2067.97
2067.96 } 2067.96
2067.94
HD 2067.55 S.L.D (2066.90)
TO 5-99-92 21

12 11
⊼@ NEBO SIGHT 5-11-90
∡'S RT 121-15-35
242-31-00 121-15-30
V∡ 90-51-30
EDM 2973.66
2973.61 } 2973.61
2973.57
HD 2973.28 S.L.D. (2972.34)
TO 5-95-92 22

12 11
⊼@ NEBO SIGHT 5-11-90
∡'S RT 129-54-00
259-47-45 129-53-53
V∡ 90-43-10
EDM 4218.08
4218.10 } 4218.10
4218.11
HD 4217.76 S.L.D. (4216.43)
TO 5-18-88 23

12 11

⊼@ NEBO SIGHT S-71-90

∢'S RT	68-31-20	
	137-02-50	68-31-25
VA	90-40-00	
EDM	1832.28	
	1832.29	1832.29
	1832.28	
HD	1832.17 S.L.O.	(1831.59)
TO	1/4 COR. 30/31	

⊼@ 1/4 COR 30/31

SIGHT NEBO

∢'S RT	83-42-35	
	167-25-20	83-42-40
VA	90-26-00	
EDM	2647.02	
	2647.02	2647.02
	2647.03	
HD	2646.94 S.L.O.	(2646.10)
TO	COR 30 29 / 31 32	

⊼@ 30 29 / 31 32 SIGHT 30/31

∢'S RT	137-42-40	
	275-25-20	
VA	89-32-00	
EDM	502.02	
	502.01	502.01
	502.01	
HD	501.99 S.L.O.	(501.83)
TO	S-71-90	

STA	+	HI	-	ELEV	Remarks
				5058.99	WELL-5~~68~~-90 TOP METAL CASING ADJUSTED
	5.501 ~~5.500~~	5064.491			
			1.603 ~~1.605~~	5062.888	
	18.016 ~~18.015~~	5080.904			
			1.698 ~~1.700~~	5079.206	
	7.806 7.805	5087.012			
			0.475	5086.537	WELL-5-97-92 TOP PVC CASING
			0.300	5086.712	" METAL "
			3.050	5083.962	GROUND
			14.503 ~~14.505~~	5072.509	
	1.801 ~~1.800~~	5074.310			
			13.043 ~~13.045~~	5061.267	
	1.511 ~~1.510~~	5062.778			
			8.473 ~~8.475~~	5054.305	
	1.386 ~~1.385~~	5055.691			
			7.893 ~~7.895~~	5047.798	
	3.451 ~~3.450~~	5051.249			
			2.305	5048.944	WELL-5-99-92 TOP PVC CASING
			2.105	5049.144	" METAL "
			4.710	5046.539	GROUND
			5.358 ~~5.360~~	5045.891	
	5.391 ~~5.390~~	5051.282			
			5.993 5.995	5045.289	
	44.8		57.		

STA	+	HI	-	ELEV
	6.391 ~~6.390~~	5051.680		
			4.318 ~~4.320~~	5047.362
	3.486 ~~3.485~~	5050.848		
			4.790	5046.058
			4.550	5046.298
			6.870	5043.978
		7.373	~~7.375~~	5043.475
	8.526 ~~8.525~~	5052.001		
			1.253 ~~1.255~~	5050.748
	8.476 ~~8.475~~	5059.224		
			0.233 ~~0.233~~	5058.991
	71.725		71.765	
	71.747		71.74[illegible]	
	+0.00167		- 0.00167	

WELL NO. S-95-92 TOP PVC CASING (WEST [illegible])
TOP METAL "
GROUND

STD	+	HI	-	ELEV	
				5049.144	TBM TOP METAL CASING 5-99-92
	2.375	5051.519			
			2.576	5048.944	
	9.245	5058.189			
			2.615	5055.574	
	5.760	5061.334			
			2.015	5059.319	WELL 5-101-92 TOP PVC CASING
			1.865	5059.469	" METAL "
			4.525	5056.809	GROUND
			7.570	5053.764	WELL 5-102-92 TOP PVC CASING
			7.375	5053.959	" METAL "
			9.790	5051.544	GROUND
			11.205	5050.129	
	3.375	5053.504			
			6.355	5047.149	
	4.545	5051.694			
			2.560	5049.134	TBM TOP M. CASING 5-99-92
	25.300		25.31		

1-04-94

⊼ L. PETERSON

Ø1 C. ANDERSEN

CLOUDY

40°

TOOELE SOUTH DEPOT AREA

EBASCO

SCALE FACTOR.

(.99968422)

(S.L. DIST)

⊼@ 5-50-90 52
SIGHT 5-43-90 51
∡'S RT 176-36-10
353-12-30
176-36-15
V∡ 90-32-20
EDM 536.26
536.28
536.29
536.28
HO. 536.25 (536.08)
TO. 5-108-93 53

⊼@ 5-50-90 52
SIGHT 5-43-90 51
∡'S RT 113-01-40
226-03-20
113-01-40
V∡ 90-03-30
EDM 669.28
669.29
669.30
669.29
HO 669.29 (669.08)
TO 5-109-93 54

⊼@ 5-50-90 52
SIGHT 5-43-90 51
∡'S RT 32-56-40
65-53-10
32-56-35
V∡ 89-31-20
EDM 1563.00
1563.00
1562.98
1562.99
HO 1562.94 (1562.45)
TO 5-110-93 55

⊼@ 5-50-90 52
SIGHT 5-43-90 51

∡'RT 135-17-15
270-34-40
135-17-20
V∡ 90-25-20
EDM 2097.17
2097.16
2097.15
2097.16
HO 2097.10 (2096.44)
TO WKPT TS941 56

⊼@ TS941 (56)

SIGHT S-50-90 (52)

∢'S RT 165-40-00 }165-40-10

331-20-20

V∢ 90-15-10

EDM 2142.18

2142.20 }2142.20

2142.22

HD 2142.18 (2141.50)

TO S-111-93 (57)

⊼@ TS941

∢'S RT 165-17-00 }165-17-03

330-34-05

V∢ 90-11-10

EDM 3709.29

3709.30 }3709.29

3709.29

HD 3709.27 (3708.10)

TO S-112-93 (58)

STA	+	HI	-	ELEV	Remarks
				5152.87	TOP METAL CASING 5-50-90.
	2.010	5154.880			
			6.825	5148.055	
	2.790	5150.845			
			4.510	5146.335	TOP METAL CASING 5-108-93
			4.740	5146.105	" PVC " "
			6.420	5144.425	GROUND "
			3.060	5147.785	
	4.725	5152.510			
			1.745	5150.765	TOP METAL CASING 5-109-93
			2.090	5150.420	" PVC " "
			4.180	5148.330	" GROUND "
			1.120	5151.390	
	3.570	5154.960			
			2.090	5152.870	5-50-90 TOP METAL CASING
	13.095		13.095		

STA	+	HI	-	ELEV	Remarks
				5152.87	TOP METAL CASING 5-50-90
	2.090	5154.960			
			4.890	5150.070	
	7.490	5157.560			
			2.735	5154.825	
	6.830	5161.655			
			3.420	5158.235	
	6.770	5165.005			
			0.110	5164.895	TOP METAL CASING 5-110-93
			0.320	5164.685	" PVC " "
			2.430	5162.575	GROUND "
			0.085	5164.920	
	0.550	5165.470			
			7.395	5158.075	
	4.980	5163.055			
			6.865	5156.190	
	0.345	5156.535			
			2.725	5153.81	
	1.520	5155.330			
			2.455	5152.875	TOP METAL CASING 5-50-90
	30.575		30.570		

STA	+	HI	-	ELEV
				5135.660
	3.940	5139.600		
			6.540	5133.060
	4.750	5137.810		
			9.335	5128.475
	3.645	5132.120		
			5.360	5126.760
	4.650	5131.410		
			5.085	5126.325
	5.000	5131.325		
			3.760	5127.565
			3.980	5127.345
			6.010	5125.315
			3.275	5128.050
	2.660	5130.710		
			5.545	5125.165
	4.680	5129.845		
			6.155	5123.690
	4.130	5127.820		
			2.280	5125.540
			2.470	5125.350
			4.990	5122.830
			2.055	5125.765
	2.395	5128.110		

TBM TS94-1

TOP METAL CASING 5-111-93
" PVC " "
GROUND

TOP METAL CASING 5-112-93
" PVC " "
GROUND

STA	+	H I	-	ELEV
				5146.335
	1.730	5148.065		
			3.030	5145.035
	3.790	5148.825		
			8.365	5140.460
	2.215	5142.675		
			7.015	5135.660
	6.885	5142.545		
			3.025	5139.520
	8.095	5147.615		
			2.035	5145.580
	2.290	5147.870		
			1.525	5146.345
	25,005		24,995	

TOP METAL CASING 5-108-93

TBM TS 94-1

TBM - TOP METAL CASING 5-108-93

STA	+	HI	-	ELEV
			4.335	5123.775
	6.260	5130.035		
			4.860	5125.175
	5.665	5130.840		
			4.815	5126.025
	5.250	5131.275		
			4.400	5126,875
	4.360	5131.235		
			3.945	5127.290
	8.255	5135.545		
			2.685	5132.860
	5.460	5138.32		
			5.265	5133,055
	6.910	5139.965		
			4.300	5135.665
	77.960		77.955	

TBM TS94-1

-19-92
L. [illegible]
W. C. ANDERSON
AX. [illegible]
-5-80

TOOELE SOOTH
ERASED.

SILVER HAWK
LOT 8